Baseline Risk Assessment

For

CHEVRON ORLANDO SITE
Orlando, Florida

EPA Work Assignment № 15

Prepared under
EPA Contract № 68-W9-0055

Prepared for

WASTE MANAGEMENT DIVISION
U.S. Environmental Protection Agency
Region IV

Prepared by

BLACK & VEATCH Waste Science, Inc.
Atlanta, Georgia

BVWS Project № 52015.014

March 24, 1995

Contents

Contents (continued)

Tables

Contents (continued)

Contents (continued)

Figures

1.0 Introduction

1.1 Overview of Risk Assessment

1.1.1 General Problem

Chevron Chemical Company/Ortho Division (Chevron Orlando Site) is located in Orlando, Orange County, Florida. The Chevron Chemical plant formerly occupied 4.39 acres located at 3100 Orange Blossom Trail in Orlando, Florida. The geographic coordinates are 28°34'44" latitude North and 81°24'32" longitude West.

The Chevron Chemical Company/Ortho Division operated as a chemical blending facility for pesticides and other crop sprays between the years of 1950 and 1976. The facility formulated a variety of liquid and powdered pesticides, citric sprays, and nutritional sprays. Chemicals used in pesticide formulation included xylene, kerosene, mineral oil, and aromatic naphtha. A few of the pesticides formulated in large volumes were chlordane, lindane, dieldrin, and aldrin.

Two unlined rinsate ponds on site were used for the collection and disposal of pesticide formulating rinse water, barrel rinse water, and storm water by evaporation and percolation. Prior to 1970, any rinsate that was not collected and reused for subsequent pesticide formulations was discharged to the two rinsate ponds. After 1970, the pesticide formulating rinsate that was not reused in pesticide formulations was collected and disposed of offsite, at an unknown location.

Chevron ceased pesticide formulating operations in 1976. The remaining inventories were removed from the site, and the rinsate ponds were backfilled with soil prior to sale of the site in 1978 to Mr. Uttal. Prior to leasing the property to Central Florida Mack Trucks Company, Mr. Uttal modified the site. The pesticide formulating equipment and left over drums were removed from the site. Following the removal, the entire interior of the building was washed with a soapy water rinse. No attempt was made to collect the rinsate. The Rinker Concrete Company poured waste loads of concrete over the rinsate pond area to develop a stronger support for the weight of trucks.

Central Florida Mack Trucks Service Center operations were conducted on the site from 1978 to 1986. These operations consisted of overhauling engines, starters, generators and front/rear ends. A degreaser was used to clean engine parts. The

degreasing operation produced about three 55-gallon drums of spent degreasing agent per year, which was collected by a contracted hauler. Mack Truck operations ended in November 1986.

In May 1989, NUS Corporation conducted a Screening Site Inspection at the Chevron Orlando Site. During this investigation surface soil, subsurface soil, and groundwater samples were collected. Pesticides (including chlordane), benzene, toluene, xylene, naphthalene, and metals were detected in surface soils. Also, the analytical results for the groundwater samples indicated the presence of metals, benzene, toluene, xylene, trichloroethylene, chlorobenzene, and pesticides.

In September 1990, Brown and Caldwell Consultants conducted a Contamination Assessment at the Chevron Orlando Site. Surface soil, subsurface soil, and groundwater samples were collected during this investigation. The results of the soil sampling indicated the presence of chlordane, xylene, dieldrin, aldrin, entrain, heptachlor, ethion, and arsenic. Benzene, toluene, xylene, chlorobenzene, aldrin, dieldrin, and heptachlor were detected in groundwater samples.

In 1991, Brown and Caldwell conducted additional sampling to better delineate areas of concern for a planned removal action. Between December 1991 and September 1992, a removal action was performed at the site. This removal consisted of excavation of 17,780 tons of pesticide-contaminated soil and 4,900 tons of soil containing petroleum hydrocarbons. Additionally, all buildings and debris were cleared from the site, and some limited groundwater treatment was accomplished. Additional surface soil and groundwater samples (Phase II) were collected during September and October 1993. These samples were collected by PTI Environmental Services. All of the surface soil samples were collected from a trailer park just north of the site. The groundwater samples were collected from both onsite and offsite monitoring well locations.

Several additional surface soil samples were collected (Phase III) from the trailer park north of the site on November 11, 1993. These samples were also collected by PTI Environmental Services. Based on the results of this investigation, Task Environmental conducted a removal action of soil from the trailer park in March and April of 1994.

1.1.2 Objectives of Risk Assessment

This baseline risk assessment evaluates the potential risks to human health and the environment due to releases of contaminants at the Chevron Orlando site. The main objective of the baseline risk assessment is to provide the information necessary to assist in the decision making process at remedial sites. The specific objectives of the baseline risk assessment are to:

- Identify and provide analysis of baseline risks (defined as risks that might exist if no remediation or institutional controls were applied at the site) and help determine what action is needed at the site.
- Provide a basis for determining the levels of chemicals that can remain onsite and still not adversely impact public health and the environment.
- Provide a basis for comparing potential health and environmental impacts of various remedial alternatives.

The baseline risk assessment provides a health assessment of potential risk to human health and ecological assessment of potential risk to the environment due to potential exposure to contaminants released from the Chevron Orlando site. The baseline risk assessment results will be used to document the magnitude of risk at the site and the associated cause of that risk. The results will also help determine what, if any, remedial response actions may be necessary and establish the remediation goals that will be presented in the feasibility study.

1.2 Site Description

The site is located at 3100 North Orange Blossom Trail (Highway 441) in Orlando, Florida. The site is bordered to the east by Orange Blossom Trail, which serves as the main access to the site, to the west by industrial facilities, to the south by railroad tracks, and to the north by a mobile home park. Lake Fairview is located approximately 1,000 feet northeast of the property. The total area of the site is 4.39 acres.

The Chevron Orlando Site is zoned commercial and is bordered by residential and light industrial-use property. The properties adjacent to the site include Armstrong Trailer Park on the north, Norther Brothers Insulation on the west, a vacant lot and

building owned by Summit Land Company on the south, and North Orange Blossom Trail on the east.

The site is located in an area known as the Osceloa Plain, a broad valley bounded by the Lake Wales Ridge on the east and the Mt. Dora and Orlando Ridges on the west. The site is at an elevation of approximately 100 feet above mean sea level. Within a 1 mile radius of the site elevations remain at 100 feet declining to 90 feet at Lake Fairview.

Prior to the removal action, there was a 6-foot difference in surveyed elevations at the site ranging from 96 feet in the swale at the northwest corner of the property to 102 feet at the southeast corner.

Excavation activities have left the site slightly more level. Post excavation elevations range from 98 feet at the northwest corner to 101 feet at the southeast corner of the property.

1.3 Scope of the Baseline Risk Assessment

The scope of this baseline risk assessment is limited to the potential risks to human health and the environment present due to exposure to contaminants in groundwater, surface soil, and subsurface soil associated with the Chevron Orlando site. The potential risks developed will be those directly related to contaminants in the media at this site. No attempt has been made to differentiate between the risk contributions from other sites and those being contributed from the Chevron Orlando site. This human health and environmental risk assessment has been derived primarily from the data collected during investigations conducted in 1991, 1992, and the 1993 Remedial Investigation. The samples evaluated reflect conditions after the onsite and offsite removal action.

The procedures used in the performance of this risk assessment and its scope are consistent with and based on EPA guidance procedures and policies for the performances of risk assessments at hazardous waste sites. The primary guidance used included the following documents:

Interim Final Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), December 1989.

Interim Final Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual, March 1989.

Supplemental Region IV Risk Assessment Guidance, March 1991.

New Interim Region IV Guidance, February 1992.

Standard Default Exposure Factors, Human Health Evaluation Manual, Supplemental Guidance, March 1991.

1.4 Organization of the Baseline Risk Assessment

The Baseline Risk Assessment for the Chevron Orlando site consists of the following:

- Data Evaluation.
- Exposure Assessment.
- Toxicity Assessment.
- Risk Characterization.
- Remedial Goal Options.
- Ecological Assessment (Environmental Evaluation).

1.4.1 Data Evaluation

This step in the risk assessment process involves "gathering and analyzing the site data relevant to the human health and ecological evaluation and identifying the contaminants present at the site" that will be included in the risk assessment process (Ref. 3).

The data used for this Baseline Risk Assessment are representative of conditions after both the onsite removal and the removal at the adjacent trailer park. However, data from environmental samples collected both before and after the offsite removal were used for the offsite scenarios because some of the corresponding sample locations were from an area where no excavation was required. All data were chosen to reflect as closely as possible current conditions at the site, taking into account all removal actions conducted to date. Black & Veatch utilized these data to develop analytical summary tables which include frequency of detections, arithmetic means, and range of sample concentrations. Using approved screening criteria, a chemicals of potential concern list was developed for each medium (Refs. 3, 13). Data evaluation and selection of chemicals of potential concern are performed in Chapter 2 of this report.

1.4.2 Exposure Assessment

An exposure assessment is conducted to estimate the magnitude of actual (current) and potential (future) human exposures to site media, the frequency and duration of these exposures, and the pathways that result in human exposures. In the exposure assessment, conservative estimates of exposure are developed for both current and future land-use assumptions. Current exposure estimates are used to determine if a threat exists based on existing exposure conditions at the site. Future exposure estimates are to provide decision makers with an understanding of potential future exposures and threats. Conducting the exposure assessment involves analyzing contaminant releases; identifying exposed populations; identifying all the potential pathways of exposure; estimating exposure point concentrations for specific pathways; and estimating contaminant intakes for specific pathways. The results of the exposure assessment are pathway-specific intakes for current and future exposures to contaminants at the site (Ref. 3). The exposure assessment is presented in Chapter 3 of this report.

1.4.3 Toxicity Assessment

The toxicity assessment involves determining the types of adverse health effects associated with chemical exposures, the relationship between magnitude of exposure and adverse effects, and the related uncertainties involved. Risk assessments rely heavily on existing toxicity information developed for specific chemicals. The two primary sources for this information are the Integrated Risk Information System database (IRIS) and the Health Effects Assessment Summary Tables (HEAST). The toxicity component in a risk assessment falls into two categories, those related to noncarcinogenic risk and those related to carcinogenic risk. To evaluate noncarcinogenic risk, the intake of a contaminant is compared to the corresponding reference dose (RfD) of that compound. The RfD used in the risk assessment is a best estimate of the level at which there will be no observed adverse effects to the exposed population. To evaluate carcinogenic risk, the intake of a contaminant is factored with the slope factor (SF) for that contaminant. The slope factor used in the risk assessment represents the 95 percent upper confidence limit for the best estimate of the carcinogenic potency of a contaminant, or its ability to cause cancers in an exposed population. For humans, both the RfDs and SFs are derived from human epidemiology studies and animal dose-response relationships (Ref. 3). The toxicity assessment is presented in Chapter 4 of this report.

1.4.4 Risk Characterization

The risk characterization section of the risk assessment summarizes and combines the exposure and toxicity assessments to characterize baseline risks, both quantitatively and qualitatively. During risk characterization, chemical-specific toxicity information is compared with the estimated exposure levels to determine whether contaminants at the site pose current or future risks that are of a magnitude to cause concern. The risk characterization is presented in Chapter 5 of this report.

1.4.5 Remediation Goal Options

Based on the results of the risk characterization, remedial goal options (RGOs) for the site will be presented. The RGO section of the baseline risk assessment will contain an appropriate narrative and media cleanup levels for chemicals that contribute to pathways that exceed a 10^{-4} risk or a hazard index of 1. Individual chemicals contributing risk to these pathways will not have RGOs developed if their contribution is less than 10^{-6} risk for carcinogens or yield a hazard quotient less than 0.1 for noncarcinogens. The tables will show the 10^{-4}, 10^{-5}, and 10^{-6} risk levels and the 0.1, 1.0, and 10 hazard quotient levels for each applicable chemical in each medium.

In cases where applicable or relevant and appropriate requirements (ARARs) have been developed for specific contaminants of concern, a comparison between these ARARs and estimated exposure levels will be made.

RGOs are presented in Section 6 of this report.

1.4.6 Environmental Assessment

The environmental assessment component of the risk assessment is a qualitative (and possibly quantitative) appraisal of the actual or potential effects of site contaminants on plants and animals other than people. The goal of the environmental assessment is to provide information on threats to the natural environment associated with contaminants or actions designed to remediate the site. The assessment addresses current as well as potential future ecological effects associated with the site. The environmental assessment also includes the identification of all potential receptors, area endangered or threatened species, and location of any critical habitats. Information derived from the data collection section was used to characterize the nature and extent of environmental risk or threat resulting from the identified

chemicals of potential concern (Ref. 5). Information gathered for the environmental risk assessment may be used to:

- Decide if remedial action is necessary based on ecological considerations.
- Evaluate the potential ecological effects of the remedial action itself.
- Provide information necessary for mitigation of any threat.
- Design monitoring strategies for assessing the progress and effectiveness of remediation.

The environmental assessment is presented in Section 7 of this report.

2.0 Data Evaluation

This step in the risk assessment process involves "gathering and analyzing the site data relevant to the human health evaluation and identifying the contaminants present at the site" that will be included in the risk assessment process (Ref. 3)

2.1 Introduction

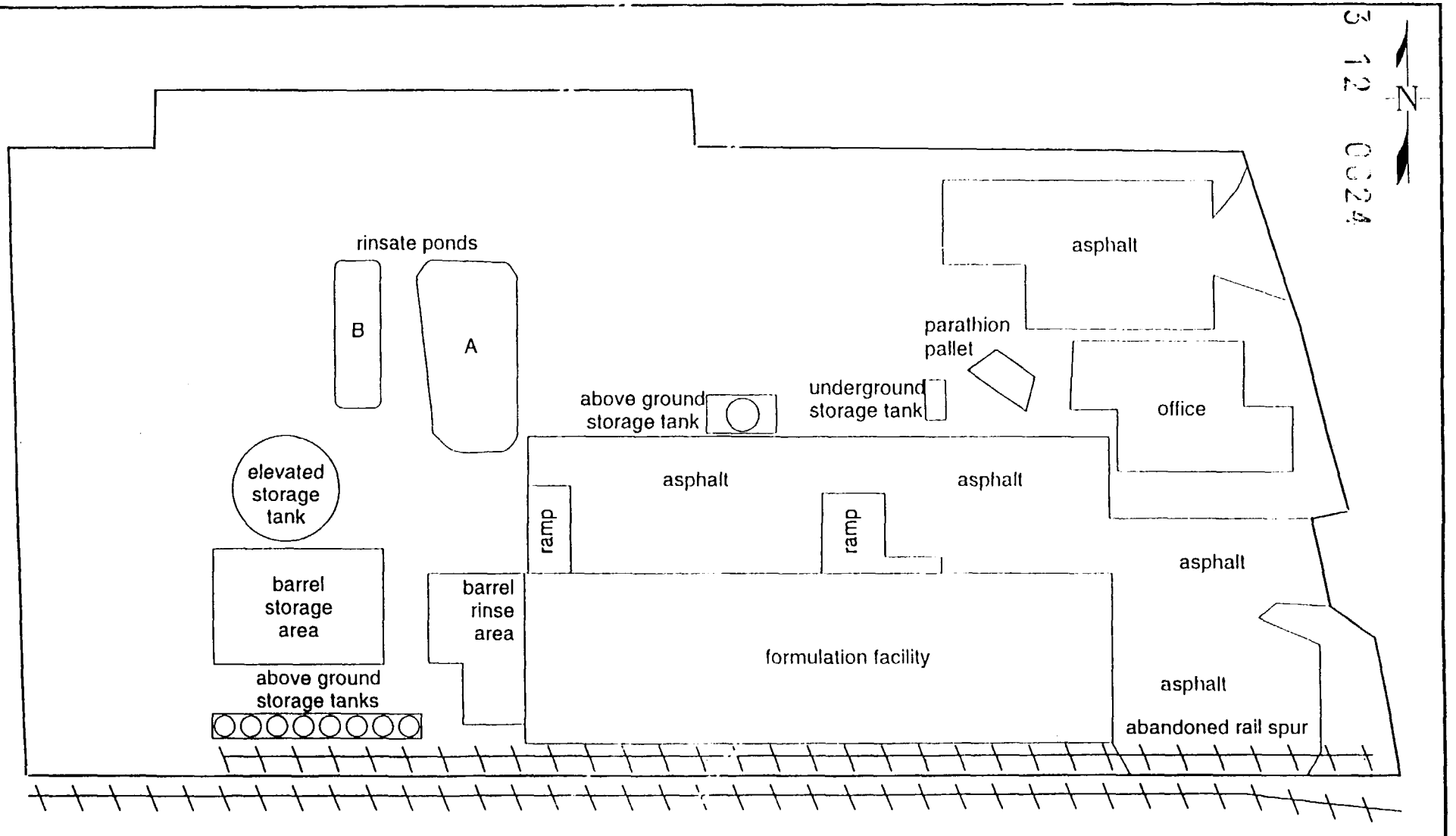
The objectives of this section are to review and summarize the analytical data for each medium sampled at the Chevron Orlando site and to select the chemicals of potential concern to be evaluated in the human health risk assessment.

Contamination at the site was characterized by multi-media sampling. Surface soil, subsurface soil, and groundwater samples were collected from each of the areas of interest (i.e., areas where chemicals of potential concern may have been released to the environment). The historic site layout is presented in Figure 2-1. The data used for this Baseline Risk Assessment are representative of conditions after both the onsite removal and the removal at the adjacent trailer park. However, data from environmental samples collected both before and after the offsite removal were used for the offsite scenarios because some of the corresponding sample locations were from an area where no excavation was required. All data were chosen to reflect as closely as possible current conditions at the site, taking into account all removal actions conducted to date. Sample locations and the year the samples were collected are presented in Figures 2-2, 2-3, and 2-4. The location of the off site excavation areas and samping locations are presented in Figure 2-5.

2.2 Evaluation and Selection of Chemicals of Potential Concern

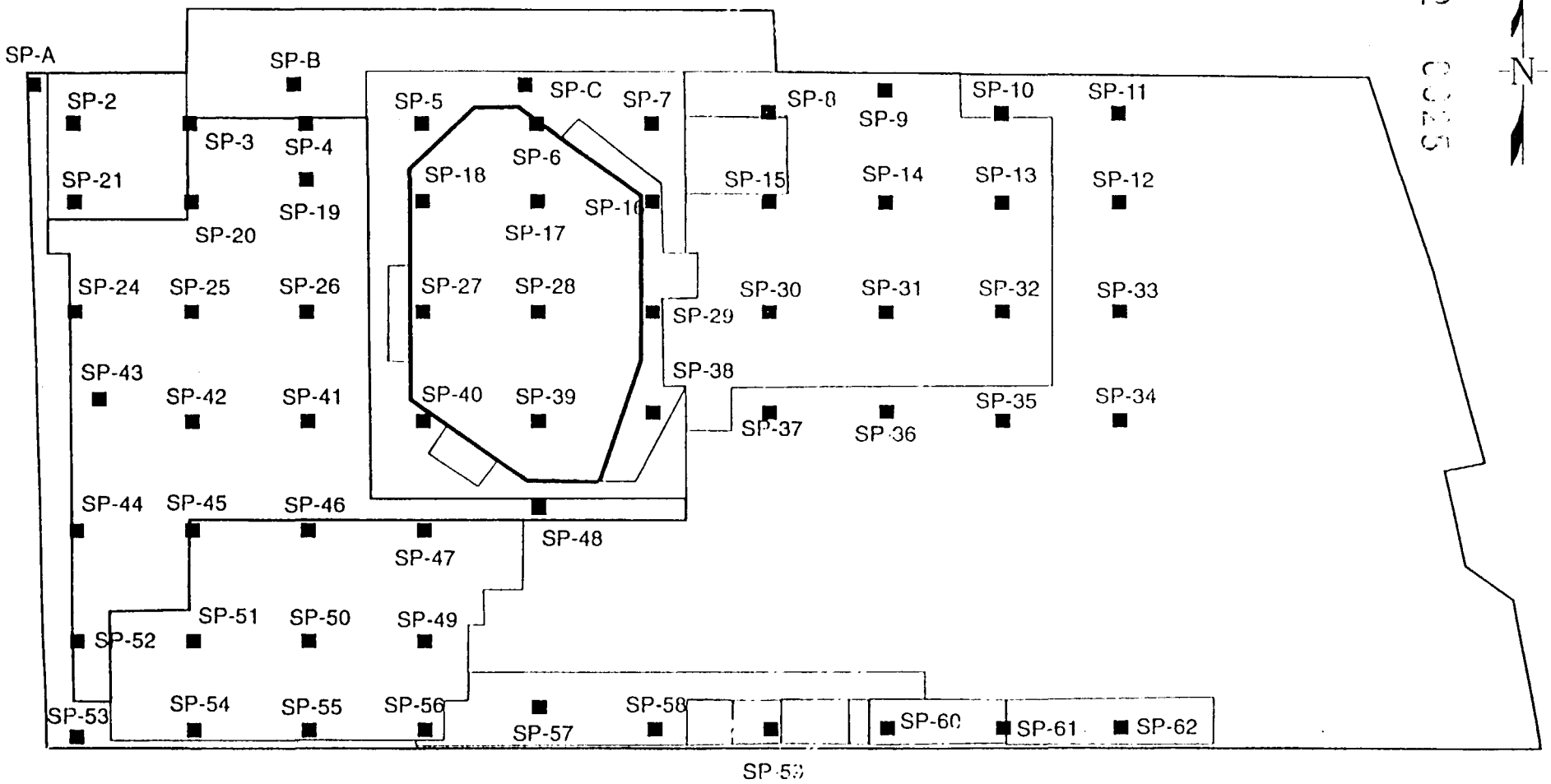
Chemicals of potential concern are a subset of all chemicals positively identified at the site. The risks associated with the chemicals of potential concern are expected to be more significant than the risks associated with other less toxic, less prevalent, or less concentrated chemicals at the site that are not evaluated quantitatively. The process of determining the chemicals of potential concern for the Chevron site included a detailed evaluation of the analytical data, a careful review of the sources of contamination and areas that the sources impact, and a review of site characteristics.

Tables 2-1 through 2-4 list all chemicals which have been identified in at least one sampling location from the following media: groundwater, offsite surface soil, and



HISTORIC SITE LAYOUT FOR FORMER
CHEVRON, ORLANDO FACILITY

FIGURE 2-1

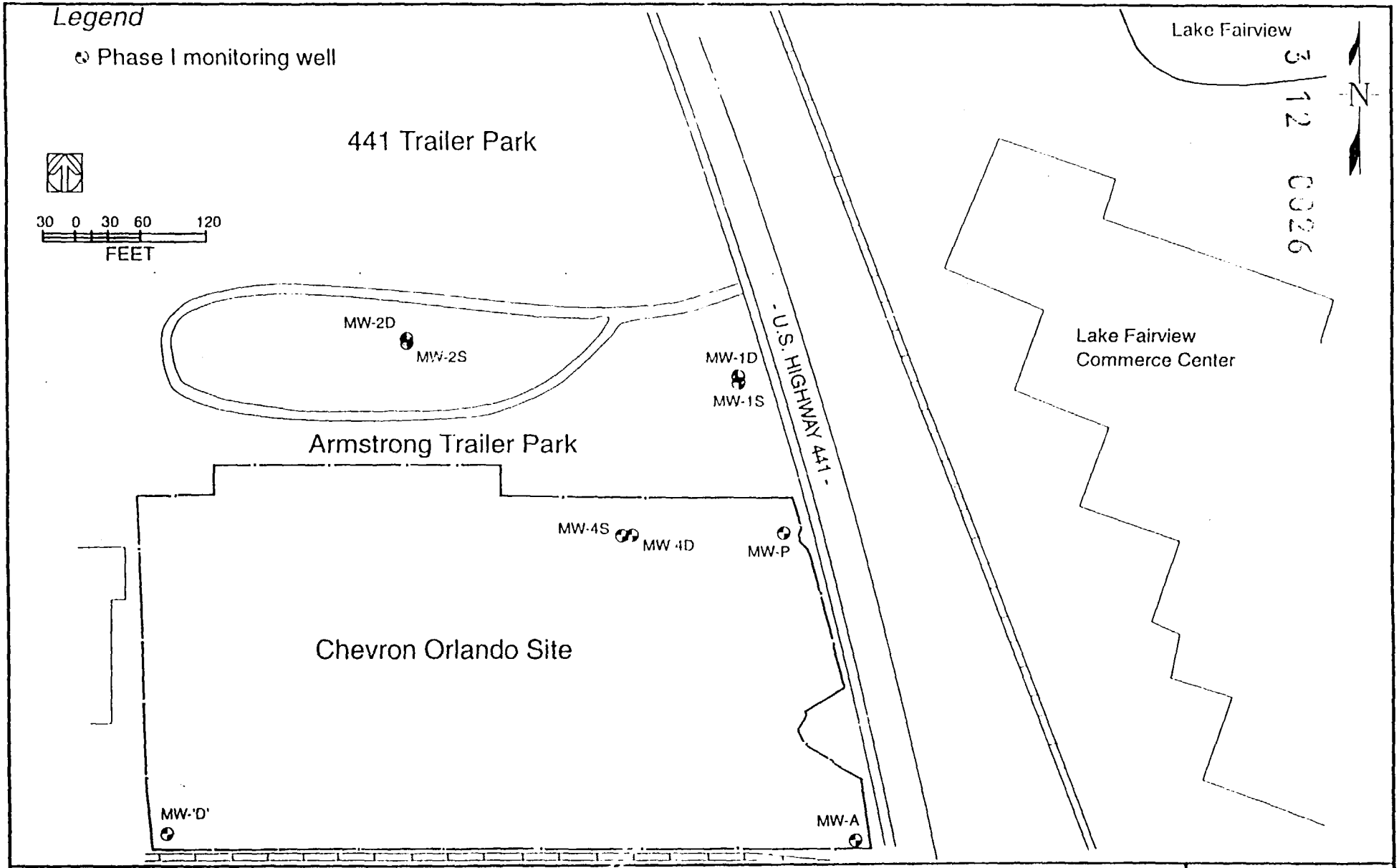


Legend

SP-53 Soil boring indentification

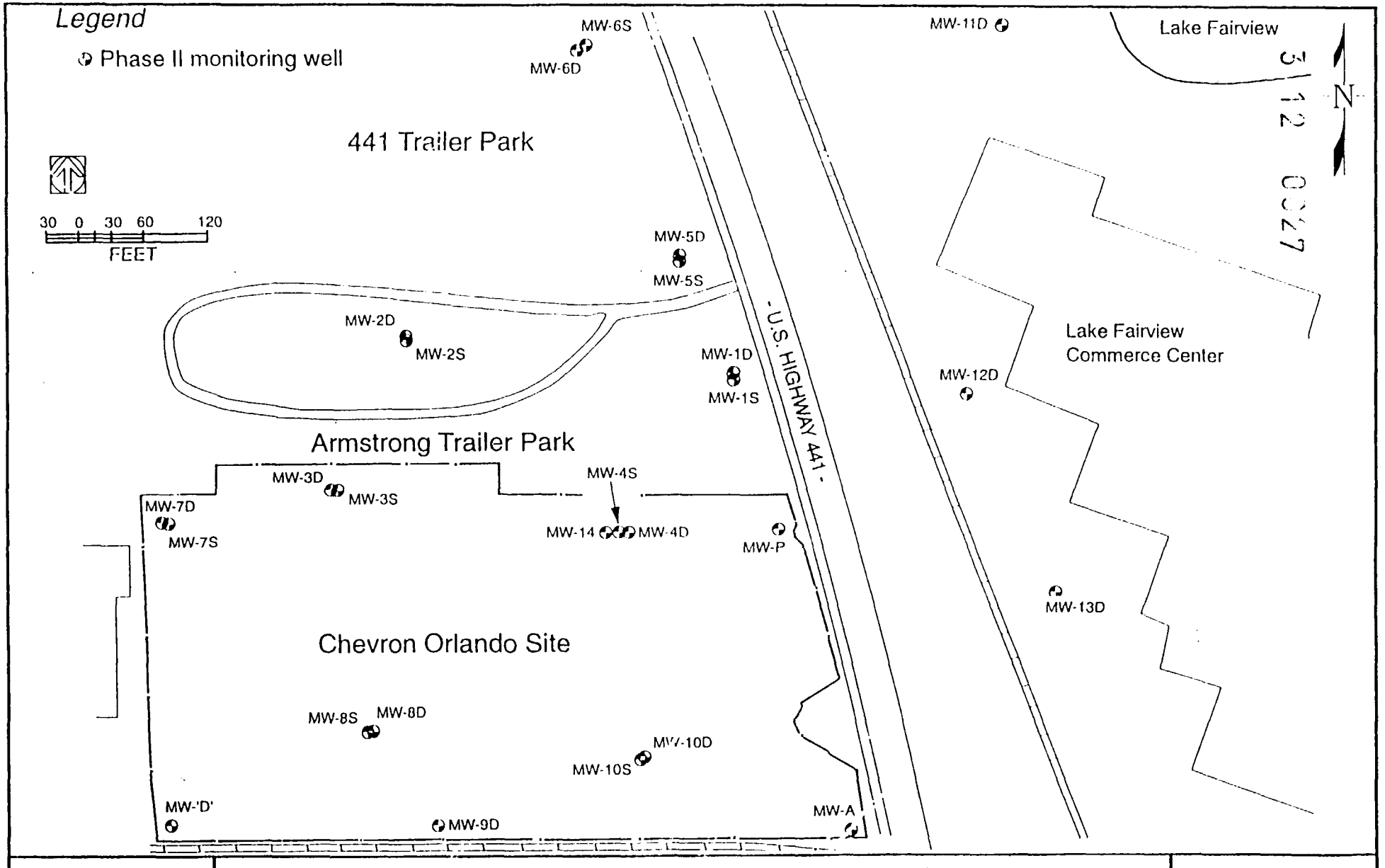
SOIL BORING LOCATIONS FROM
1991 REMOVAL ACTION PLAN (BCC 1991)
CHEVRON, ORLANDO SITE

FIGURE 2-2



MONITORING WELLS SAMPLED DURING PHASE I
GROUNDWATER INVESTIGATION, APRIL 1993
CHEVRON, ORLANDO SITE

FIGURE 2-3



MONITORING WELLS SAMPLED DURING PHASE II
GROUNDWATER INVESTIGATION, SEPTEMBER 1993
CHEVRON, ORLANDO SITE

FIGURE 2-4

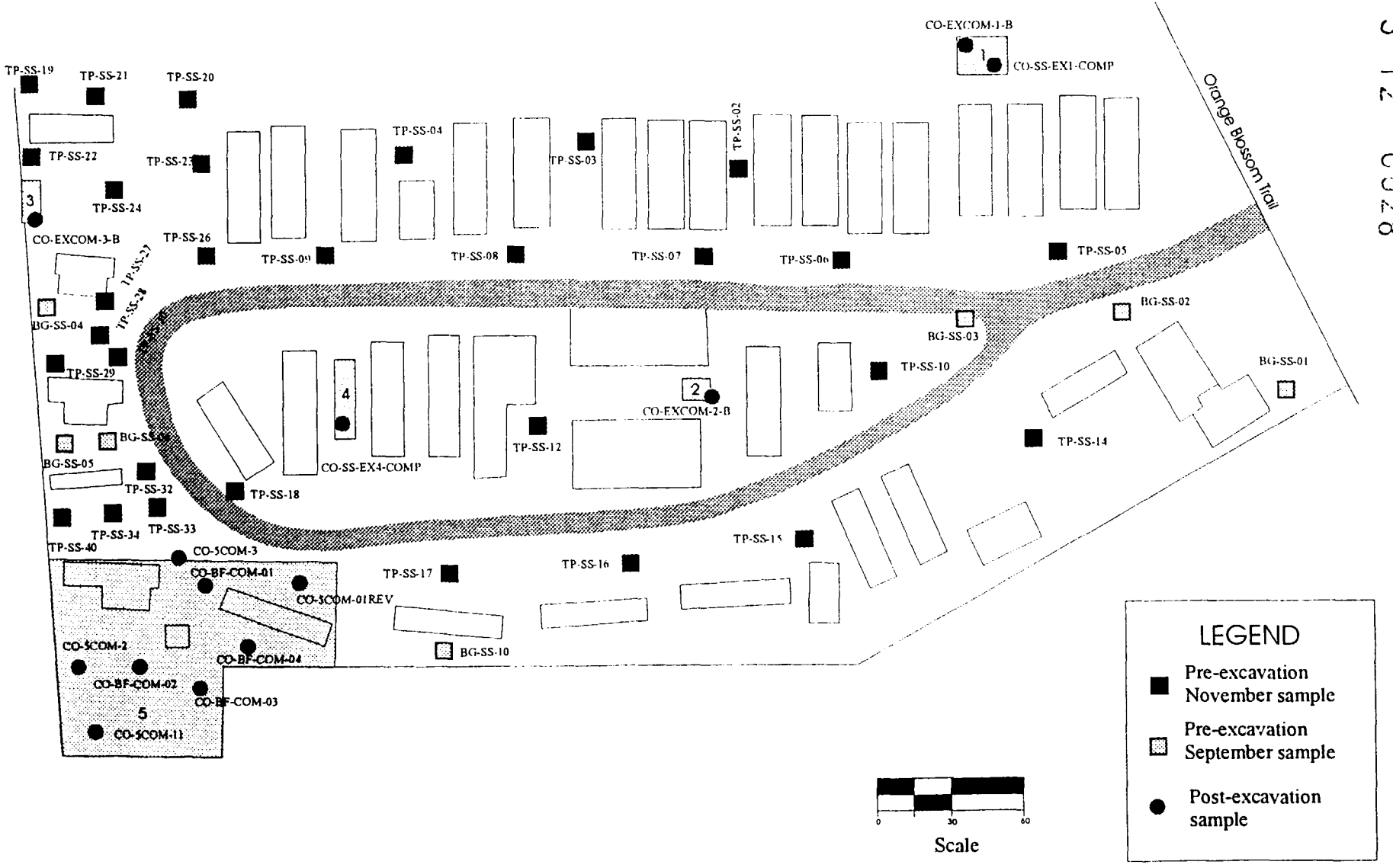


FIGURE 2-5 SAMPLE LOCATION MAP - OFF SITE SOIL SAMPLES
BASELINE RISK ASSESSMENT
CHEVRON CHEMICAL, ORLANDO, FLORIDA

TABLE 2-1
CHEMICALS DETECTED IN SHALLOW GROUNDWATER
CHEVRON ORLANDO SITE

Chemical	Frequency of Detection	Range of Detects (ug/l)	Average Detected Concentration (1) (ug/l)	Region III Screening Values (2) (ug/l)	REASON FOR ELIMINATION (If applicable)
VOLATILE ORGANICS					
CHLOROETHANE	1 / 25	3.0 - 3.0	3.0	860	Does not exceed screening concentration
1,1-DICHLOROETHANE	3 / 25	0.8 - 9.7	5.0	81	Does not exceed screening concentration
1,2-DICHLOROBENZENE	5 / 25	2.6 - 8	4.0	37	Does not exceed screening concentration
1,2-DICHLOROPROPANE	1 / 25	0.6 - 0.6	0.6	0.16	Detected at less than 5% frequency
1,4-DICHLOROBENZENE	6 / 25	5.7 - 24	11.4	0.44	
BENZENE	8 / 25	1.1 - 22	6.6	0.36	
CHLOROBENZENE	9 / 25	1.4 - 62	15.9	3.9	
CHLOROFORM	1 / 25	2.3 - 2.3	2.3	0.15	Detected at less than 5% frequency
ETHYLBENZENE	11 / 25	0.9 - 2000	250	130	
TOLUENE	7 / 25	1.2 - 12	6	75	Does not exceed screening concentration
XYLENES	12 / 25	4 - 5900	659	1200	
BASE NEUTRAL ORGANICS					
1,2,4-TRICHLOROBENZENE	1 / 25	20 - 20	20	19	Detected at less than 5% frequency
2,4-DIMETHYLPHENOL	2 / 25	22 - 28	25	73	
2-METHYLNAPHTHALENE	6 / 25	26 - 110	52	NL	
2-METHYLPHENOL	1 / 25	26 - 26	26	180	Detected at less than 5% frequency
DI-N-BUTYL PHTHALATE	7 / 25	10 - 64	33	370	Does not exceed screening concentration
NAPHTHALENE	3 / 25	38 - 112	64	NL	
BIS(2-ETHYLHEXYL)PHTHALATE	1 / 25	36 - 36	36	4.8	Found in less than 5% of samples
DI-N-OCTYLPHTHALATE	1 / 25	32 - 32	32	73	Does not exceed screening concentration
PESTICIDE/PCBs					
4,4'-DDD	2 / 25	2.3 - 3	2.7	0.28	
ALPHA-BHC	11 / 25	0.14 - 9.2	2.9	0.011	
BETA-BHC	11 / 25	0.32 - 70	10	0.037	
CHLORDANE	1 / 25	12 - 12	12.0	0.052	Detected at less than 5% frequency
DELTA-BHC	11 / 25	0.09 - 37	8.9	NL	
GAMMA-BHC	3 / 25	1 - 3.6	1.9	0.052	
NALED	1 / 25	14 - 14	14.0	7.30	Detected at less than 5% frequency
PARATHION ETHYL	1 / 25	15 - 15	15	22	Does not exceed screening concentration
AROCHLOR-1260	2 / 25	3.1 - 45	24	0.0087	
INORGANICS					
ARSENIC	3 / 25	11 - 46	25	1.1000	
CHROMIUM	10 / 25	0.05 - 1.6	0.27	18	Does not exceed screening concentration
LEAD	21 / 25	5 - 330	61	NL	

NL - Not Listed

ND - Not Detected

(1) Only samples with detects where used when calculating average concentrations for each compound

(2) These values were obtained from EPA Region III Risk based concentrations technical guidance for selecting chemicals of potential concern

The values listed represent tapwater criteria (11/8/94).

TABLE 2-2
PESTICIDES DETECTED IN ONSITE SOIL SAMPLES (SURFACE)
CHEVRON ORLANDO SITE

Chemical	Frequency of Detection	Range of Detects (mg/kg)	Average Detected Concentration (1) (mg/kg)	Region III Screening Values (2) (mg/kg)	REASON FOR ELIMINATION (if applicable)
PESTICIDE/PCBs					
4,4'-DDD	25 / 81	0.04 - 21	4.226	2.70	
4,4'-DDE	12 / 79	0.147 - 3.1	1.246	1.9	
4,4'-DDT	27 / 81	0.053 - 58	4.229	1.9	
ALDRIN	5 / 82	0.019 - 13	3.434	0.038	
ALPHA-BHC	4 / 82	1.1 - 130	34.475	0.10	Detected at less than 5% frequency
BETA-BHC	7 / 82	0.005 - 21	3.462	0.35	
CHLORDANE	54 / 82	0.088 - 79	8.96	0.49	
DELTA-BHC	3 / 81	0.012 - 3.3	1.90	NL	Detected at less than 5% frequency
DIELDRIN	12 / 79	0.029 - 11	2.486	0.04	
ENDRIN	5 / 77	0.081 - 2.2	0.70	2.30	Does not exceed screening concentration
GAMMA-BHC	1 / 82	1 - 1	1.00	0.49	Detected at less than 5% frequency
HEPTACHLOR EPOXIDE	4 / 80	0.0058 - 0.6	0.24	0.07	
METHOXYCHLOR	1 / 82	0.053 - 0.053	0.053	39	Does not exceed screening concentration

NL - Not Listed

ND - Not Detected

(1) Only samples with detects where used when calculating average concentrations for each compound

(2) These values were obtained from EPA Region III Risk based concentrations technical guidance for selecting chemicals of potential concern
The values listed represent residential soil concentrations (11/8/94)

TABLE 2-3
CHEMICALS DETECTED IN ONSITE SOIL SAMPLES (SURFACE AND SUBSURFACE)
CHEVRON ORLANDO SITE

Chemical	Frequency of Detection	Range of Detects (mg/kg)	Average Detected Concentration (1) (mg/kg)	Region III Screening Values (2) (mg/kg)	REASON FOR ELIMINATION (If applicable)
VOLATILE ORGANICS					
TOLUENE	4 / 72	0.12 - 3.2	1.4	1600	Does not exceed screening value
CHLOROBENZENE	9 / 72	0.17 - 5.8	1.6	160	Does not exceed screening value
ETHYLBENZENE	10 / 72	0.13 - 85	12.0	780	Does not exceed screening value
1,2-DICHLOROBENZENE	9 / 72	0.16 - 1.1	0.5	700	Does not exceed screening value
1,4-DICHLOROBENZENE	10 / 72	0.53 - 9.5	3.2	27	Does not exceed screening value
XYLENES	23 / 72	0.13 - 420	49.0	16000	Does not exceed screening value
BASE NEUTRAL ORGANICS					
PYRENE	2 / 70	0.45 - 0.66	0.6	230	Does not exceed screening value
METHYL TERT-BUTYL ETHER	10 / 70	0.17 - 2.8	0.6	39	Does not exceed screening value
2-METHYLNAPHTHALENE	8 / 70	0.65 - 12	3.2	NL	
BIS(2-ETHYLHEXYL)PHTHALATE	8 / 70	0.35 - 0.69	0.5	46	Does not exceed screening value
1,2,4-TRICHLOROBENZENE	1 / 70	0.84 - 0.84	0.8	78	Does not exceed screening value
PESTICIDE/PCBs					
4,4'-DDD	126 / 271	0.011 - 210	21	2.70	
4,4'-DDE	49 / 215	0.007 - 21	3.9	1.90	
4,4'-DDT	50 / 271	0.053 - 58	6.5	1.90	
ALDRIN	19 / 225	0.019 - 23	5.8	0.038	
ALPHA-BHC	13 / 225	0.5 - 130	15.2	0.1	
BETA-BHC	15 / 225	0.005 - 21	2.6	0.35	
CHLORDANE	187 / 273	0.048 - 350	35	0.49	
DELTA-BHC	21 / 216	0.0011 - 8.3	2.2	NL	
DIELDRIN	56 / 222	0.029 - 19	3.2	0.04	
ENDRIN	14 / 216	0.014 - 6.7	1.8	2.30	
GAMMA-BHC	12 / 225	0.3 - 19	5.24	0.49	
HEPTACHLOR EPOXIDE	6 / 216	0.0058 - 3.4	1.2	0.07	Detected at less than 5% frequency
METHOXYCHLOR	1 / 216	0.053 - 0.053	0.053	39	Does not exceed screening concentration

NL - Not Listed

(1) Only samples with detects where used when calculating average concentrations for each compound

(2) These values were obtained from EPA Region III Risk based concentrations technical guidance for selecting chemicals of potential concern.
The values listed represent residential soil concentrations (11/8/94).

TABLE 2-4
CHEMICALS DETECTED IN TRAILER PARK SOIL SAMPLES (SURFACE)
CHEVRON ORLANDO SITE

Chemical	Frequency of Detection	Range of Detects (mg/kg)	Average Detected Concentration (1) (mg/kg)	Region III Screening Values (2) (mg/kg)	REASON FOR ELIMINATION (If applicable)
VOLATILE ORGANICS					
ACETONE	1 / 7	0.088 - 0.088	0.088	780	Does not exceed screening concentration
BASE NEUTRAL ORGANICS					
DI-N-BUTYL PHTHALATE	3 / 7	0.33 - 1.9	0.900	780	Does not exceed screening concentration
PESTICIDE/PCBs					
4,4'-DDD	9 / 53	0.009 - 0.1	0.029	2.70	Does not exceed screening concentration
4,4'-DDE	45 / 53	0.0091 - 0.55	0.132	1.90	Does not exceed screening concentration
4,4'-DDT	46 / 53	0.006 - 0.9	0.145	1.90	Does not exceed screening concentration
CHLORDANE	50 / 53	0.0042 - 5.3	1.147	0.49	
DIELDRIN	16 / 53	0.0079 - 1.1	0.155	0.04	
ENDOSULFAN	1 / 46	0.026 - 0.026	0.026	47	Does not exceed screening concentration
ENDRIN	1 / 53	0.16 - 0.16	0.160	2.3	Detected at less than 5% frequency
HEPTACHLOR EPOXIDE	2 / 46	0.007 - 0.011	0.004	0.070	Detected at less than 5% frequency
METHOXYCHLOR	2 / 46	0.025 - 0.086	0.056	39.0	Detected at less than 5% frequency
HEPTACHLOR	2 / 56	0.008 - 0.019	0.013	0.14	Does not exceed screening concentration
a-BHC	1 / 56	0.014 - 0.014	0.014	0.1	Does not exceed screening concentration
g-BHC	1 / 56	0.015 - 0.015	0.015	0.5	Does not exceed screening concentration
INORGANICS					
CHROMIUM	7 / 7	3.0 - 11.0	6.0	39	Does not exceed screening concentration
LEAD	7 / 7	15.0 - 130.0	79.0	NL	

NL - Not Listed

ND - Not Detected

(1) Only samples with detects where used when calculating average concentrations for each compound

(2) These values were obtained from EPA Region III Risk based concentrations technical guidance for selecting chemicals of potential concern

The values listed represent residential soil concentrations (7/11/94).

onsite soil (surface and subsurface). Tables 2-1 through 2-4 identify the frequency of detection for each chemical, the range of detected concentrations, the arithmetic mean of the detected concentrations, and the reason for eliminating certain chemicals based on the following screening criteria:

(1) Inorganic or organic chemicals were eliminated if the detected concentrations were not significantly greater than blank concentrations (Ref.3).

(2) Concentrations of detected chemicals were compared to EPA Region III screening criteria (Ref. 13). If the maximum detected concentration was not equal to or greater than a carcinogenic risk of 10^{-6} or a hazard quotient of 0.1, the chemical was eliminated from consideration (Ref. 13).

(3) Inorganic chemicals were eliminated if the chemical was considered to be an essential nutrient and had relatively low toxicity (i.e., calcium, magnesium, iron, potassium, and sodium).

(4) Organic chemicals were eliminated if the chemical was detected in less than 5 percent of the samples analyzed and was detected at low concentrations.

The compounds retained as chemicals of potential concern for all media are summarized in Table 2-5.

Table 2-5
Chemicals of Potential Concern
Chevron Orlando Site
Risk Assessment

		Media		
Contaminant	Onsite Surface Soil	Onsite Surface and Subsurface Soil	Trailer Park Surface Soil	Shallow Groundwater
ORGANICS				
Benzene				X
Chlorobenzene				X
Ethylbenzene				X
Xylenes				X
1,4-Dichlorobenzene				X
2,4-Dimethylphenol				X
2-Methylnaphthalene*		X		X
Naphthalene				X
Chlordane	X	X	X	
Heptachlor epoxide	X			
Aldrin	X	X		
Dieldrin	X	X	X	
4,4'-DDD	X	X		X
4,4'-DDT	X	X		
4,4'-DDE	X	X		
Arochlor -1260				X
Endrin		X		
a-BHC		X		X
b-BHC	X	X		X
g-BHC		X		X
d-BHC*		X		X
INORGANICS				
Arsenic				X
Lead			X	X

*This compound was retained as a chemical of potential concern in onsite surface and subsurface soil, and shallow groundwater. However, it does not have an EPA-approved reference dose or cancer slope factor; therefore, it will not be evaluated in the quantitative risk assessment.

3.0 Exposure Assessment

3.1 Overview of Exposure Assessment

The objective of the exposure assessment is to estimate the types and magnitudes of exposures to chemicals of potential concern that are present at or migrating from the site. The results of the exposure assessment are combined with chemical-specific toxicity information to characterize potential risk (Ref. 3). The assessment of exposures presented in this section is based upon and consistent with current EPA guidance (Ref. 3).

The purpose of the exposure assessment is to estimate the magnitude of potential human exposure to the chemicals of potential concern at the Chevron Orlando site. The results of the exposure assessment are subsequently combined with chemical-specific toxicity information to quantitatively estimate the potential human health risks associated with chemical exposure.

The exposure assessment process involves four main steps:

- Characterization of the exposure setting.
- Identification of the exposure pathways.
- Quantification of the exposure.
- Identification of uncertainties in the exposure assessment.

3.2 Characterization of the Exposure Setting

3.2.1 Physical Setting

3.2.1.1 Demography and Land Use. The Chevron Orlando site is located at 3100 North Orange Blossom Trail (Highway 441) in Orlando, Florida. The site is bordered to the east by Orange Blossom Trail, which serves as the main access to the site, to the west by industrial facilities, to the south by railroad tracks, and to the north by a mobile home park. Lake Fairview is located approximately 1,000 feet northeast of the property. The total area of the site is 4.39 acres.

The site is zoned commercial and is bordered by residential and light industrial-use property. The properties adjacent to the site include Armstrong Trailer Park on the north, Norther Brothers Insulation on the west, a vacant lot and building owned by

Summit Land Company on the south, and North Orange Blossom Trail on the east.

A total of 15,454 homes are served by wells located 2.2 miles from the site. Three of these wells are owned by Orlando Utilities and two are owned by Winter Park Utilities (Ref. 10). The nearest residential area is the Armstrong Trailer Park located just north of the site.

3.2.1.2 Water uses. Orange County is underlain by three aquifers, the surficial aquifer, a shallow artesian aquifer system, and the Floridan aquifer. Groundwater flow at the site is generally in a northeast direction (Refs. 9, 11).

The unconfined surficial aquifer extends over most of Orange County. The depth to water in the surficial aquifer ranges from 5 to 10 feet below land surface (bls). Wells in the surficial aquifer are 20 to 30 feet deep. These wells yield water for domestic use (Ref. 11).

Underlying the surficial aquifer is the shallow artesian aquifer system consisting of discontinuous shell beds, sand and gravel zones, and thin limestone lenses. Aquifers in the shallow artesian are found locally and occur at depths ranging from 60 to 150 feet bls. Recharge to this system occurs by downward leakage from the shallow aquifer and by upward leakage from the Floridan aquifer (Ref. 11)

The Floridan aquifer supplies most of Florida with freshwater. The Floridan is located from 150 feet bls to 2,000 feet bls with potable water extending to approximately 1,750 feet. It is composed of limestone and dolomite and has two producing zones separated by a relatively impermeable zone. The upper potable water producing zone extends from 150 feet to approximately 600 feet. The lower production zone extends from 1,100 to 1,500 feet bls. Recharge to the Floridan is by infiltration of rainfall in outcrop areas and by downward leakage from overlying aquifers. In addition, there are over 300 drainage wells in the county which artificially recharge the aquifer (Ref. 11).

All residents in the study area rely on groundwater for potable water. The Orlando Utilities Commission Water Department (OUCWD) and the Winter Park Utilities Water Department (WPUWD) have wells located within a 4-mile radius of the site. Two OUCWD wells are located 2.2 miles southeast of the site. These wells are

blended with other OUCWD wells, which collectively serve 89,000 homes in the Orlando and surrounding counties. The OUCWD wells are approximately 1,320 feet deep. WPUWD has two wells located 2.2 miles northeast of the site. Water from these wells is blended with other wells in the system. The WPUWD wells are approximately 1,200 feet deep and serve 21,000 homes in the Orlando area. It is estimated that there are 1,377 area homes which rely on private wells for potable water. The nearest private well is located approximately 2,700 feet from the Chevron facility (Ref. 11).

Surface water from the site drains southwest across railroad tracks to an adjacent property occupied by North Brothers Insulation Company. This area commonly floods during periods of heavy rains. Because of the lack of surface streams some surface water drainage flows into sinkholes and other closed depressions(Refs. 9, 11).

3.2.1.3 Climatology. Orange County is located in a subtropical climate and is characterized by warm, humid summers and mild, relatively dry winters. Annual county rainfall averages 22 inches (Ref. ssi). The wet season extends from February through May, and the driest period occurs from September to October. Average yearly temperatures range from 61° F and 81° F (Ref. 12).

3.2.1.3.1 Dispersion climatology. The dispersive capacity of the atmosphere is of primary interest when estimating the potential for the atmospheric migration of site emissions from contaminated surface soil. As on-site meteorological monitoring was not within the scope of the remedial investigation, wind speed and direction can be estimated based on data available from the National Oceanic and Atmospheric Administration (NOAA).

The closest residential area is the Armstrong Trailer Park which borders the site to the north. Based on the location of the trailer park, winds from the south would provide the most critical wind conditions for air emissions (Ref. 16).

3.2.2 Potentially Exposed Populations

The site is currently not occupied, but is zoned commercial. Therefore, there are currently no onsite workers. Since residential areas are located north of the site, there is a possibility of trespassers gaining access to the site and the surrounding area. Although a removal action was conducted in March and April of 1994, nearby

residents living in the trailer park north of the site could still potentially be exposed to contaminants in offsite surface soil.

The site is surrounded by residential and light-industrial use. The Chevron Orlando site will likely remain commercial, and nearby property is likely to remain residential or light-industrial in the near future. Assuming the site zoning remains commercial, the only additional populations which could be exposed to contaminants (onsite or offsite) include workers. However, a future onsite resident scenario will be evaluated so that all potential future onsite populations are included in the risk assessment. There is also the possibility for any hypothetical future onsite and off-site residents to be exposed to contaminated groundwater, assuming a private well could be installed on or near the site.

3.3 Identification of Exposure Pathways

The Chevron Orlando facility operated as a pesticide and crop spray blender from 1950 to 1976. The facility formulated a variety of liquid and powdered pesticides, citric sprays, and nutritional sprays. Chemicals used in pesticide formulation xylene, kerosene, mineral oil, and aromatic naphtha. A few of the pesticides formulated in large volumes were chlordane, lindane, dieldrin, and aldrin. Principal contaminants detected at the site during previous investigations include chlordane, benzene, toluene, xylene, aldrin, and dieldrin. The risk assessment evaluates potential risks due to exposure to groundwater and soil (surface and subsurface).

3.3.1 Exposure Pathways Analysis

The conceptual site model for the Chevron Orlando site (Figure 3-1) incorporates information on the potential chemical sources, affected media, release mechanisms, routes of migration, and known or potential human receptors. The purpose of the conceptual site model is to provide a framework with which to identify potential exposure pathways occurring at the site. Information presented in the Draft Remedial Investigation Report, local land and water uses, and potential receptors was used to identify potential exposure pathways at the site.

An exposure pathway consists of four elements: 1) a source and mechanism of chemical release; 2) a retention or transport medium (or media in cases involving media transfer of chemicals); 3) a point of potential human contact with the

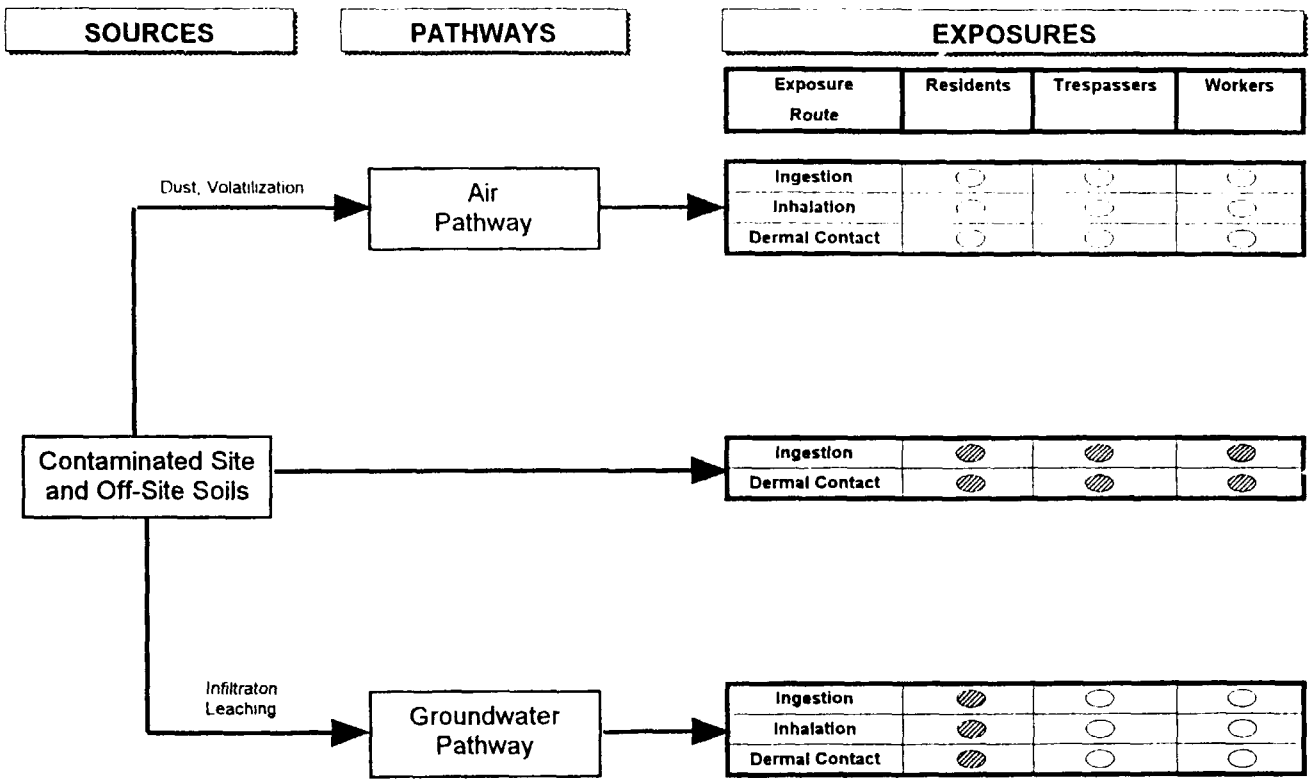


Figure 3-1
Conceptual Site Model

Chevron Chemical Company/Ortho Division
Orlando, Orange County, Florida

contaminated medium; and 4) an exposure route (i.e., ingestion) at the contact point (Ref. 3). When all of these elements are present, the pathway is considered complete. The assessment of pathways by which human receptors may be exposed to contaminants includes an examination of existing migration pathways (i.e., soil andgroundwater) and exposure routes (i.e., ingestion and dermal absorption), as well as those that may be reasonably expected in the future.

After the sources of contaminants are identified, the next step in the development of the conceptual model is to determine mechanisms of release to environmental media. The primary release mechanisms are infiltration, runoff, and volatilization.

Contaminated groundwater and surface soil are believed to be the major sources of potential exposure for human receptors. The following paragraphs describe the pathways by which human receptors can be exposed to contaminated media. The conceptual site model is presented in Figure 3-1.

3.3.1.1 Groundwater. Groundwater beneath the Chevron site became contaminated through the leaching of waste from the unlined rinsate ponds, and possibly from leaks or spills from past plant operations. The subsequent infiltration of precipitation resulted in contaminant movement from surface and subsurface soil to groundwater. Exposure to contaminated groundwater is not evaluated in the current offsite resident scenario because city water is currently supplied to the immediate vicinity surrounding the site. However, groundwater use is evaluated for the future resident, since under future use conditions, a private well could potentially be installed as a source of potable water.

3.3.1.2 Surface Soil. Onsite and offsite surface soil samples were collected during the investigation. Subsurface soil samples were also collected. A future onsite maintenance worker and construction worker may be exposed to contaminants in surface soils. A future construction worker may also be exposed to contaminants in subsurface soil. Another potential future use may involve developing the site for residential use. Therefore, a future resident will be evaluated for exposure to onsite surface soil.

3.3.2 Exposure Scenarios

This narrative discusses the rationale for selection of exposure pathways and routes of concern for both the current and future exposure scenarios.

The air pathway was not quantitatively evaluated as an exposure pathway for volatilized or particulate emissions from the surface soil for the following reasons:

1) No volatile organic compounds were retained as chemicals of potential concern in surface soil (See Tables 2-2 and 2-3).

2) The average wind speed in the vicinity of the site (6.8 mph) is higher than the most critical range for volatilized chemicals. Winds in the range of 3 to 5 mph are the most critical as they result in a steady movement of emissions with minimal dispersive mixing.

3) As discussed in Section 1.1.1, a total of 22,680 tons of contaminated soil were removed from the site in 1991 and 1992. The contaminated soil was then replaced with clean fill material.

4) With the exception of the entrance road, the site is vegetated. Grassy areas are not subject to wind erosion. In "Rapid Assessment of Exposure to Particulate Emissioins from Surface Contaminated Sites", Cowherd characterizes various surface materials based on their wind erosion potential. According to Cowherd et.al., areas similar to the entrance road are characterized as having a "limited reservoir of erodible material. Such surfaces require high threshold wind speeds for wind erosion to occur, and particulate emission rates tend to decay rapidly during and erosion event. It was assumed that exposure via inhalation of fugitive dust would be negligible based on the small surface area of the entrance road relative to the rest of the site and the fact that it is doubtful the road was significantly contaminated by former site activities, .

3.3.2.1 Future Onsite Workers. If the site remains industrial in the future, an onsite worker or construction worker were assumed to be exposed to site-related contaminants in surface soil while working onsite. A future construction worker may also be exposed to contaminants in subsurface soil. The routes of exposure

considered for the onsite worker and construction worker were incidental ingestion and dermal contact with contaminants in soil.

3.3.3.2 Current Offsite Resident. Current offsite residents living in the Armstrong Trailer Park may be exposed to site-related contaminants in offsite surface soil. Potential exposure routes include incidental ingestion of, and dermal contact with offsite surface soil.

3.3.2.3 Future Resident. Based on surrounding land use, it was assumed that residential development might occur onsite in the future. Potential pathways through surface soil exposure included in incidental ingestion and dermal contact. Groundwater was evaluated due to the hypothetical possibility of future contamination of offsite private drinking wells or the installation of a residential well onsite. The potential exposure pathways involved the ingestion of drinking water.

3.4 Quantification of Exposure

The basic equation used to calculate human intake of an environmental contaminant was (Ref. 3):

$$DI = C \times HIF$$

Where:

DI = Daily Intake (mg of chemical per kg of body weight per day)
C = Concentration of the chemical in mg/kg (ppm)
HIF= Human Intake Factor (kg of medium per kg body weight per day)

Each intake variable in the above equation has a range of values. The intake variable values for a given pathway were selected so that the combination of all intake variables resulted in an estimate of the reasonable maximum exposure that can be expected to occur (Ref. 3). This section describes the method by which the exposure concentrations and the human intake factors were derived.

3.4.1. Exposure Point Concentrations

The concentration term used in the intake equations is an estimate of the arithmetic average concentration for a contaminant based on a set of site sampling results. Due to the uncertainty associated with estimating the true average concentration at a site, the 95 percent upper confidence limit (UCL) of the arithmetic mean was used for

this variable. Contaminant concentrations reported as "non-detect" were assumed to be equal to one-half the quantitation limit for the calculation of exposure point concentrations. Where this value (95 percent UCL) exceeded the maximum detected concentration, or was less than the minimum detected concentration, the maximum detected concentration was used as the exposure point concentration.

In accordance with Region IV guidance, the following formula was used to determine the 95 percent UCL of the arithmetic mean of the log-transformed data (Ref. 6):

$$UCL = e^{\left(\bar{x}_i + 0.5S^2 + \frac{SH}{\sqrt{(N-1)}}\right)}$$

Where:

e = constant (natural log)

$\bar{x}_i$ = arithmetic mean of the log-transformed data for contaminant i

S = standard deviation of the log-transformed data

$$S = \frac{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x}_i)^2}}{n-1}$$

H = statistic determined by the standard deviation and sample size

n = sample size for contaminant in the particular media set

Tables 3-1 through 3-4 list the exposure point concentrations for onsite surface and subsurface soil, offsite surface soil, and groundwater. Table 3-5 lists the samples which were used in calculating exposure point concentrations for all media. The data used for this Baseline Risk Assessment are representative of conditions after both the onsite removal and the removal at the adjacent trailer park. However, data from environmental samples collected both before and after the offsite removal were used for the offsite scenarios because some of the corresponding sample locations were from an area where no excavation was required. All data were chosen to reflect as closely as possible current conditions at the site, taking into account all removal actions conducted to date.

Table 3-1
Shallow Groundwater
Chevron Orlando Site
Risk Assessment

Compound or Analyte (ug/l)	95% Upper Confidence Limit	Maximum Value	Exposure Point Concentration
VOLATILE ORGANICS			
1,4-DICHLOROBENZENE	5.6E+00	2.4E+01	2.4E+01
BENZENE	4.2E+00	2.2E+01	4.2E+00
CHLOROBENZENE	9.9E+00	6.2E+01	9.9E+00
ETHYLBENZENE	2.4E+06	2.0E+03	2.0E+03
XYLENES	2.9E+04	5.9E+03	5.9E+03
BASE NEUTRAL ORGANICS			
2,4-DIMETHYLPHENOL	7.4E+00	2.8E+01	2.8E+01
2-METHYLNAPHTHALENE	2.3E+01	1.1E+02	1.1E+02
NAPHTHALENE	1.4E+01	1.1E+02	1.1E+02
PCB-1260	2.1E+00	4.5E+01	2.1E+00
PESTICIDE/PCBs			
4,4'-DDD	3.2E-01	3.0E+00	3.0E+00
ALPHA-BHC	1.4E+01	9.2E+00	9.2E+00
BETA-BHC	8.2E+01	7.0E+01	7.0E+01
DELTA-BHC	1.5E+02	3.7E+01	3.7E+01
GAMMA-BHC	2.6E-01	3.6E+00	3.6E+00
INORGANICS			
ARSENIC	8.3E+00	4.6E+01	4.6E+01
LEAD	1.2E+02	3.3E+02	1.2E+02

Table 3-2

Onsite Soil Samples (Surface)

Chevron Orlando Site

Risk Assessment

Compound or Analyte (mg/kg)	95% Upper Confidence Limit	Maximum Value	Exposure Point Concentration
PESTICIDE/PCBs			
4,4'-DDD	2.5E+00	2.1E+01	2.5E+00
4,4'-DDE	1.1E+00	3.1E+00	1.1E+00
4,4'-DDT	1.4E+00	5.8E+01	1.4E+00
ALDRIN	1.2E+00	1.3E+01	1.2E+00
BETA-BHC	1.1E+00	2.1E+01	1.1E+00
CHLORDANE	8.6E+00	7.9E+01	8.6E+00
DIELDRIN	1.2E+00	1.1E+01	1.2E+00
HEPTACHLOR EPOXIDE	9.3E-01	6.0E-01	6.0E-01

Table 3-3

Onsite Soil Samples (Surface and Subsurface)

Chevron Orlando Site

Risk Assessment

Compound or Analyte (mg/kg)	95% Upper Confidence Limit	Maximum Value	Exposure Point Concentration
PESTICIDE/PCBs			
4,4'-DDD	1.7E+01	2.1E+02	1.7E+01
4,4'-DDE	2.1E+00	2.1E+01	2.1E+00
4,4'-DDT	2.7E+00	5.8E+01	2.7E+00
ALDRIN	1.5E+00	2.3E+01	1.5E+00
ALPHA-BHC	1.4E+00	1.3E+02	1.4E+00
BETA-BHC	1.2E+00	2.1E+01	1.2E+00
CHLORDANE	4.6E+01	3.5E+02	4.6E+01
DIELDRIN	2.0E+00	1.9E+01	2.0E+00
GAMMA-BHC	1.4E+00	1.9E+01	1.4E+00
ENDRIN	1.1E+01	6.7E+00	6.7E+00

Table 3-4
Trailer Park Soil Samples (Surface)
Chevron Orlando Site
Risk Assessment

Compound or Analyte (mg/kg)	95% Upper Confidence Limit	Maximum Value	Exposure Point Concentration
CHLORDANE	3.9E+00	5.3E+00	3.9E+00
DIELDRIN	6.6E-02	1.1E+00	6.6E-02
INORGANICS			
LEAD	2.5E-01	1.3E-01	1.3E-01

TABLE 3-5
SAMPLES USED FOR EPC'S
CHEVRON CHEMICAL RISK ASSESSMENT

Groundwater	Offsite surface soil (0-1')	Onsite Subsurface Soil (0-10')				Onsite Surface Soil (0-1')	
GW-MW-1S	BG-SS-01	CO-EC-01-01	CO-EC-63-03	RA 84-5	SPT-59-02	Berm 1	RA 157-1
GW-MW-1D	BG-SS-02	CO-EC-02-01	CO-EC-64-03	RA 85-2	SPT-59-03	Berm 14	RA 158-1
GW-MW-2S	BG-SS-03	CO-EC-03-01	CO-EC-65-01	RA 86-2	SPT-59-2.5	Berm 15	RA 27-1
GW-MW-2D	BG-SS-04	CO-EC-04-01	CO-EC-66-01	RA 87-3	SPT-59dup	Berm 16	RA 32-1
GW-MW-3S	BG-SS-05	CO-EC-05-01	CO-EC-67-01	RA 90-3	SPT-60-02	Berm 17	RA 44-1
GW-MW-3D	BG-SS-06	CO-EC-06-01	CO-EC-68-01	RA 91-2	SPT-60-03	Berm 18	RA 46-1
GW-MW-4S	BG-SS-10	CO-EC-07-01	CO-EC-69-01	RA 92-3	SPT-62-01	Berm 19	RA 48-1
GW-MW-4D	TP-SS-02	CO-EC-08-01	CO-EC-70-01	RA 96-2	SPT-62-02	Berm 2	RA 50-1
GW-MW-5S	TP-SS-03	CO-EC-09-01	CO-EC-71-01	RT 14-2	SPT-B	Berm 3	RA 51-1
GW-MW-5D	TP-SS-04	CO-EC-10-01	CO-EC-72-03	RT 15-2	SPT-E	Berm 4	RA 52-1
GW-MW-6S	TP-SS-05	CO-EC-11-01	CO-EC-73-03	RT 22-5	SPT-G	Berm 5	RA 53-1
GW-MW-6D	TP-SS-06	CO-EC-12-01	CO-EC-74-03	RT 22-6	SPT-H	Berm 6	RA 54-1
GW-MW-7S	TP-SS-07	CO-EC-13-01	CO-EC-75-03	RT 23-6	*	CO-EC-31	RA 62-1
GW-MW-7D	TP-SS-08	CO-EC-14-01	CO-EC-76-03	RT 24-3		CO-EC-31dup	RA 63-1
GW-MW-8S	TP-SS-09	CO-EC-15-01	CRT 11-2	RT 24-4		CO-EC-77	RA 76-1
GW-MW-8D	TP-SS-10	CO-EC-16-01	CRT 14-1	RT 25-2		CO-EC-78	RA 77-1
GW-MW-9D	TP-SS-12	CO-EC-17-01	CRT 14-2	RT 29-4		CO-EC-79	RA 78-1
GW-MW-10S	TP-SS-14	CO-EC-18-01	CRT 15-2	RT 30-4		CO-EC-80	RA 79-1
GW-MW-10D	TP-SS-15	CO-EC-19-01	CRT 9-2	RT 30-5		CO-EC-81	RA 80-1
GW-MW-11	TP-SS-16	CO-EC-20-01	DEEP EX-1	RT 31-4		CO-EC-82	RA31-1
GW-MW-12	TP-SS-17	CO-EC-21-01	DEEP EX-2	RT 31-5		CO-EC-83	RT 5-1
GW-MW-13	TP-SS-18	CO-EC-22-01	DEEP EX-3	RT 32-7		CO-EC-84	SA FILL-1
GW-MW-A	TP-SS-19	CO-EC-23-01	DEEP EX-4	RT 34-7		CO-EC-85	
GW-MW-D	TP-SS-20	CO-EC-24-01	DEEP EX-5	SASG-3		CO-EC-86	
GW-MW-P	TP-SS-21	CO-EC-25-01	DEEP EX-6	SPT-07-02		CO-EC-87	
	TP-SS-22	CO-EC-26-01	RA 10-2	SPT-07-03		CO-EC-88	
	TP-SS-23	CO-EC-27-01	RA 102-4	SPT-10-01		CO-EC-89	
	TP-SS-24	CO-EC-28-01	RA 103-4	SPT-10-02		CO-EC-90	
	TP-SS-26	CO-EC-32-01	RA 109-2	SPT-11-01		CO-EC-90dup	
	TP-SS-27	CO-EC-33-01	RA 112-2	SPT-11-02		CO-EC-91	
	TP-SS-28A	CO-EC-34-02	RA 113-2	SPT-12-01		CO-EC-92	
	TP-SS-28B	CO-EC-35-02	RA 13-4	SPT-12-02		FM-1	
	TP-SS-29	CO-EC-36-02	RA 137-2	SPT-20-01		FM-2	
	TP-SS-30	CO-EC-37-02	RA 138-2	SPT-20-02		PSLAB-1	
	TP-SS-31	CO-EC-38-02	RA 139-2	SPT-20-03		PSLAB-10	
	TP-SS-32A	CO-EC-39-03	RA 140-2	SPT-21-01		PSLAB-11	
	TP-SS-32B	CO-EC-40-03	RA 141-2	SPT-21-02		PSLAB-12	
	TP-SS-33	CO-EC-41-03	RA 142-2	SPT-21-03		PSLAB-13	
	TP-SS-34	CO-EC-42-03	RA 143-2	SPT-24-01		PSLAB-14	
	TP-SS-40A	CO-EC-43-01	RA 144-2	SPT-24-02		PSLAB-15	
	TP-SS-40B	CO-EC-44-01	RA 150-6	SPT-24-03		PSLAB-16	
	CO-EXCOM-2-B	CO-EC-45-01	RA 151-6	SPT-33-01		PSLAB-2	
	CO-EXCOM-3-B	CO-EC-46-01	RA 18-2	SPT-33-02		PSLAB-3	
	CO-5COM-1rev	CO-EC-47-03	RA 18-4	SPT-33-03		PSLAB-4	
	CO-5COM-2	CO-EC-48-03	RA 18-5	SPT-34-01		PSLAB-5	
	CO-5COM-3	CO-EC-49-03	RA 26-3	SPT-34-02		PSLAB-6	
	CO-5COM-11	CO-EC-50-03	RA 26-4	SPT-35-01		PSLAB-7	
	CO-BF-COM-01	CO-EC-51-03	RA 26-5	SPT-35-02		PSLAB-8	
	CO-BF-COM-02	CO-EC-52-03	RA 27-2	SPT-35dup		PSLAB-9	
	CO-BF-COM-03	CO-EC-53-03	RA 27-3	SPT-36-01		RA 1-1	
	CO-BF-COM-04	CO-EC-54-03	RA 27-4	SPT-36-02		RA 117-1	
	CO-SS-EX1-COMP	CO-EC-55-03	RA 33-2	SPT-37-01		RA 14-1	
	CO-SS-EX4-COMP	CO-EC-56-03	RA 36-2	SPT-37-02		RA 145-1	
		CO-EC-57-03	RA 37-2	SPT-37-03		RA 146-1	
		CO-EC-58-03	RA 38-2	SPT-37-2.5		RA 147-1	
		CO-EC-59-03	RA 39-2	SPT-57-01		RA 148-1	
		CO-EC-60-03	RA 40-2	SPT-57-02		RA 149-1	
		CO-EC-61-03	RA 46-2	SPT-58-01		RA 15-1	
		CO-EC-62-03	RA 56-2	SPT-58-02		RA 153-1	
			RA 83-5	SPT-58dup		RA 154-1	

* -Although they are not explicitly listed here, samples collected onsite in the 0 - 1' interval are also included in the 0 - 10' listing.

3.4.2 Exposure Dose Algorithms and Assumptions

This subsection presents the mathematical models that are used to calculate the intakes (i.e., doses) of chemicals of potential concern by each receptor through the applicable exposure routes.

The EPA has developed exposure algorithms for use in calculating chemical intakes through the exposure pathways and routes that are relevant for this site. These algorithms combine the chemical exposure point concentrations with potential pathways and route-specific parameters to produce potential daily chemical intakes or doses in terms of milligrams of chemical that could be taken into the body per kilogram of body weight per day (mg/kg-day).

The exposure models and assumptions are presented in the Tables 3-5 through 3-9. Each table defines the exposure route variables and includes assumptions (i.e., exposure parameters) used in the model for each scenario. Additional information regarding the assumptions are presented in the text. EPA Region IV Supplemental and Interim Guidance documents for risk assessments (Refs. 6, 7) were used where appropriate.

Daily chemical intakes are calculated for each exposure route applicable to the current/future offsite resident (adult and child), current/future adolescent (ages 7-16) onsite trespasser, future onsite residents (adult and child), and future workers (onsite workers and construction workers). Daily chemical intakes are estimated separately for potential carcinogenic and noncarcinogenic health effects in accordance with U.S. EPA methodology (Ref. 3). For all the scenarios, doses are averaged over the number of days of exposure (years of exposure x 365 days/year) to evaluate noncarcinogenic health effects, and over a lifetime (70 years x 365 days/year) to evaluate potential carcinogenic health effects.

The future onsite worker scenario assumes that an individual works at the site for 25 years, while the future construction worker scenario assumes that an individual works at the site for a period of one year. It is also assumed that an adult is at work 5 days a week for 50 weeks per year (250 days total) (Ref. 8). It is assumed that onsite workers would only be exposed to surface soil (0 - 1 foot bls) and construction workers would be exposed to all soils (0 - 10 feet bls).

The residential scenario assumes that individuals live in the same residence for 30 years (Ref. 8). In addition, it is assumed that the residents take about two weeks of vacation per year, spending 350 days per year at home (Ref. 8). Two age groups are evaluated for the current offsite and future onsite resident including a child (age 1-6) and an adult. The body weights used for the child (age 1-6) and adult are 15 kilograms and 70 kilograms, respectively.

3.4.2.1 Ingestion of Groundwater. Drinking water ingestion is considered to be a potential exposure route for future adult and child residents assuming a private well is installed on or near the site. The drinking water ingestion rates used for the child and adults assume that all daily water intake occurs at home. The equations and assumptions that are used to calculate drinking water ingestion intakes are presented in Table 3-6. The drinking water ingestion rate for the adult resident is 2 L/day (Ref. 8). In the absence of data for children, it is assumed that the children residents will ingest one-half of the daily adult amount or 1 L/day.

Based on the values in Table 3-6, the average daily intakes of groundwater via ingestion by a future child resident are:

DI (chronic) = C x HIF (chronic) = CW (mg/L) x 6.40E-2 (L/kg/day)
DI (lifetime) = C x HIF (lifetime) = CW (mg/L) x 5.48E-3 (L/kg/day)

Based on the values in Table 3-6, the average daily intakes of groundwater via ingestion by future adult resident are:

DI (chronic) = C x HIF (chronic) = CW (mg/L) x 2.74E-2 (L/kg/day)
DI (lifetime) = C x HIF (lifetime) = CW (mg/L) x 9.40E-3 (L/kg/day)

3.4.2.2 Inhalation of Groundwater while Showering. Volatile organic compounds (VOCs) may be released to indoor air through a variety of home activities, including showering, cooking, dish washing, and laundering clothes. Inhalation while showering is evaluated to account for doses of VOCs received from nonpotable uses of water for the future adult and child residents. Some researchers believe that inhalation doses of VOCs through typical home water uses may be as great or greater than doses from the ingestion of water. Based on experimental results for the transfer of trichloroethene from water to air in the shower stall, McKone and Knezovich (1991) report that inhalation exposures in showers could be equivalent to drinking water ingestion contact of 1 to 4 liters. Therefore, the dose

TABLE 3-6
Model for Calculating Doses from Ingestion of Groundwater
CHEVRON CHEMICAL COMPANY/ORTHO DIVISION
ORLANDO, ORANGE COUNTY, FLORIDA

$$\text{Groundwater Ingestion Dose (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

WHERE:

CW	=	Chemical concentration in groundwater (mg/l)
IR	=	Ingestion rate (L/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

ASSUMPTIONS:

CS	=	Exposure point concentration in groundwater.
IR	=	1 liter/day for the child (1-6 resident) (Ref. 3). 2 liter/day, for the adult resident (Ref. 3).
EF	=	350 days/year for the child and adult residents (Ref. 8).
ED	=	6 years for the child (1-6) resident (Ref. 8). 24 years for adult resident (Ref. 8)
BW	=	15 kg for the child (1-6) resident (Ref. 8). 70 kg for the adult resident (Ref. 8).
AT	=	Exposure Duration (years) x 365 days/year for evaluating noncancer risk (Ref. 8). 70 years x 365 days/year for evaluating cancer risk (Ref. 8).

from inhalation of VOCs while showering is based on an overall ingestion equivalent of two liters per day as described by McKone and Knezovich (Ref. 29).

3.4.2.3 Incidental Ingestion of Surface Soil by Residents/Trespassers. Incidental soil ingestion can result from placing soil-covered hands or objects in the mouth. Ingestion of surface soil is a potential route of exposure for current/future offsite residents, future onsite residents, and current/future onsite adolescent trespassers.

The current/future offsite resident and the future onsite resident are assumed to be exposed to surface soil on a daily basis, year-round. Surface soil exposure is assumed to occur during outdoor activities, such as yard work and recreational activities. A year-round exposure (350 days per year) to surface soil will be assumed (Ref. 8). It has been estimated that children ages 1-6 incidentally ingest 200 mg of soil on a daily basis and that individuals over the age of 6 ingest 100 mg of soil per day (Ref. 8). Therefore, the residential exposure is divided into two age groups to reflect these varying ingestion rates.

The exposure dose model and assumptions for the soil ingestion route are presented in Table 3-7.

Based on the values in Table 3-7, the average daily intakes (DI) of soil via incidental ingestion by current/future child offsite resident and future child onsite resident are:

DI (chronic) = C x HIF (chronic) = CS (mg/kg) x 1.28E-5 (kg/kg/day)
DI (lifetime) = C x HIF (lifetime) = CS (mg/kg) x 1.10E-6 (kg/kg/day)

Based on the values in Table 3-7, the average daily intakes (DI) of soil via incidental ingestion by current/future adult offsite resident and future adult onsite resident are:

DI (chronic) = C x HIF (chronic) = CS (mg/kg) x 1.37E-6 (kg/kg/day)
DI (lifetime) = C x HIF (lifetime) = CS (mg/kg) x 4.70E-7 (kg/kg/day)

Based on the values presented in Table 3-7, the average daily intakes (DI) of soil via incidental ingestion by current/future adolescent trespassers are:

DI (chronic) = C x HIF (chronic) = CS (mg/kg) x 6.09E-7 (kg/kg/day)
DI (lifetime) = C x HIF (lifetime) = CS (mg/kg) x 8.70E-8 (kg/kg/day)

TABLE 3-7
Model for Calculating Doses from Incidental Ingestion of Surface Soil
CHEVRON CHEMICAL COMPANY/ORTHO DIVISION
ORLANDO, ORANGE COUNTY, FLORIDA

$$\text{Soil Ingestion Dose (mg/kg-day)} = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

WHERE:

CS	=	Chemical concentration in soil (mg/kg)
IR	=	Soil ingestion rate (mg/day)
CF	=	Conversion factor (10^{-6} kg/mg)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

ASSUMPTIONS:

CS	=	Exposure point concentration in soil.
IR	=	100 mg/day, adults and adolescent trespassers (Ref. 8) 200 mg/day, child (ages 1-6) (Ref. 8)
EF	=	350 days/year for current and future child/adult on-site residents 100 days/year for current and future adolescent on-site trespassers (Ref. 8)
ED	=	10 years, adolescent trespasser 24 years, adult (Ref. 8) 6 years, child (ages 1-6) (Ref. 8)
$AT_{non-carcinogenic}$	=	Exposure Duration (years) * 365 days/year for evaluating noncancer risk (Ref. 8).
$AT_{carcinogenic}$	=	70 years * 365 days/year for current/future child and adult offsite residents, current/future adolescent onsite trespassers, and future child and adult onsite residents (Ref. 8)
BW	=	70 kg, adult (Ref. 8) 15 kg, child (Ref. 8) 45 kg, adolescent trespasser (Ref. 7)

3.4.2.4 Dermal Contact With Surface Soil by Residents/Trespassers. Dermal contact with soil could result in absorption of chemicals through the skin. The dermal absorption of chemicals from the surface soil is a potential exposure route for current/future offsite residents, future onsite residents, and current/future adolescent trespassers. The equation and assumptions that were used to calculate absorbed doses are presented in Table 3-8.

The exposed skin surface areas used to evaluate dermal contact with surface soil are outlined below:

- Current/Future Offsite Adult Resident, Current/Future Onsite Adolescent Trespasser, and Future Onsite Adult Resident are based on the hands, arms and lower legs of an adult.
- Current/Future Offsite Child Resident and Future Onsite Child Resident is based on the hands, arms, legs, and feet of a child ages 1 to 6.

As indicated in Section 3.4.2, it is assumed that current/future offsite child and adult residents and future onsite child and adult residents are assumed to be exposed to surface soil 350 days per year. Current and future onsite adolescent trespassers are assumed to be exposed to surface soil 100 days per year (2 site visits per week, 50 weeks per year).

The following absorption factors, as recommended in the EPA Region IV Guidance (Ref. 7), were used: 1.0 percent for organics and 0.1 percent for inorganics. EPA Region IV guidance (Ref. 7) recommends a range of 0.2-1.0 mg/cm^2 for the soil to skin adherence factors. An adherence factor of 1.0 mg/cm^2 was used.

Intake (expressed as absorbed dose) from dermal exposure to soil can be calculated by using the equation on Table 3-8 (Ref. 3).

Based on the values on Table 3-8, average daily intakes (DI) of soil by dermal absorption for current/future offsite child resident and future onsite child resident are:

DI (chronic) = C x HIF (chronic) = CS (mg/kg) x ABS X 2.02E-4 (kg/kg/day)
DI (lifetime) = C x HIF (lifetime) = CS (mg/kg) x ABS x 1.73E-5 (kg/kg/day)

TABLE 3-8
Model for Calculating Doses from Dermal Contact with Surface Soil
CHEVRON CHEMICAL COMPANY/ORTHO DIVISION
ORLANDO, ORANGE COUNTY, FLORIDA

$$\textit{Soil Dermal Absorption Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

WHERE:

CS	=	Chemical concentration in soil (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
SA	=	Skin surface area available for contact (cm^2/day)
AF	=	Soil to skin adherence factor (mg/cm^2)
ABS	=	Dermal absorption factor (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

ASSUMPTIONS:

CS	=	Exposure point concentration in soil.
SA	=	3,160 cm^2, child: hands, arms, and legs (Ref. 8) 5,300 cm^2, adult and adolescent trespasser: hands, arms, and lower legs (Ref. 8)
AF	=	1.0 mg/cm^2, soil adherence factor (Ref. 7).
ABS	=	0.01 - Organic compounds (Ref. 7) 0.001 - Inorganic compounds (Ref. 7)
EF	=	350 days/year for current and future child/adult residents (Ref. 8) 100 days/year for current/future adolescent trespassers (Ref. 8)
ED	=	6 years, child (ages 1-6) (Ref. 8) 24 years, adult (Ref. 8) 10 years, adolescent trespasser (Ref. 7)
BW	=	15 kg, child (ages 1-6) (Ref. 8) 70 kg, adult (Ref. 8) 45 kg, adolescent trespasser (Ref. 7)
$AT_{non\text{-}carcinogenic}$	=	Exposure Duration (years) * 365 days/year for evaluating noncancer risk (Ref. 8)
$AT_{carcinogenic}$	=	70 years * 365 days/year for current/future child and adult offsite residents, current/future child and adult onsite trespassers, and future onsite residents (Ref. 8)

Based on the values on Table 3-8, average daily intakes (DI) of soil by dermal absorption for current/future offsite adult resident and future onsite adult resident are:

DI (chronic) = C x HIF (chronic) = CS (mg/kg) x ABS X 7.26E-5 (kg/kg/day)
DI (lifetime) = C x HIF (lifetime) = CS (mg/kg) x ABS x 2.49E-5 (kg/kg/day)

Based on the values in Table 3-8, average daily intakes (DI) of soil by dermal absorption for current/future onsite adolescent trespassers are:

DI (chronic) = C x HIF (chronic) = CS (mg/kg) x ABS X 3.23E-5 (kg/kg/day)
DI (lifetime) = C x HIF (lifetime) = CS (mg/kg) x ABS x 4.61E-5 (kg/kg/day)

3.4.2.5 Incidental Ingestion of Soil by Workers. Incidental soil ingestion results from placing soil-covered hands or objects in the mouth. Ingestion of surface (0 - 1 feet) and subsurface soil (0 -10 feet) is a potential route of exposure for future onsite workers and construction workers, respectively. The soil ingestion rate for onsite workers is 50 mg/day, while a soil ingestion rate of 200 mg/day is assumed for the onsite construction worker (Ref. 3). It is assumed that an onsite worker will be exposed to contaminants in onsite surface soil 5 days a week for 50 weeks a year (a total of 250 days per year) for a period of 25 years. The future construction worker scenario assumes that an individual is exposed to contaminants in surface and subsurface soil 250 days for a period of one year.

Incidental ingestion of contaminated soil was calculated using the equation listed in Table 3-9 (Ref. 3):

Based on the values in Table 3-9, the average daily intakes (DI) of surface soil by incidental ingestion for future onsite workers are:

DI (chronic) = C x HIF (chronic) = CS (mg/kg) x 4.89E-7 (kg/kg/day)
DI (lifetime) = C x HIF (lifetime) = CS (mg/kg) x 1.75E-7 (kg/kg/day)

Based on the values in Table 3-9, the average daily intakes (DI) of soil via incidental ingestion for future construction workers are:

DI (chronic) = C x HIF (chronic) = CS (mg/kg) x 1.96E-6 (kg/kg/day)
DI (lifetime) = C x HIF (lifetime) = CS (mg/kg) x 2.80E-8 (kg/kg/day)

3.4.2.6 Dermal Contact with Soil by Workers. Dermal contact with soil could result in the absorption of chemicals through the skin. The dermal absorption of

TABLE 3-9
Model for Calculating Doses from Incidental Ingestion of Surface and Subsurface Soil for Future Workers and Construction Workers
CHEVRON CHEMICAL COMPANY/ORTHO DIVISION
ORLANDO, ORANGE COUNTY, FLORIDA

$$\text{Soil Ingestion Dose (mg/kg-day)} = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

WHERE:

CS	=	Chemical concentration in soil (mg/kg)
IR	=	Soil ingestion rate (mg/day)
CF	=	Conversion factor (10^{-6} kg/mg)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

CS	=	Exposure point concentration in soil.
IR	=	200 mg/day, adult construction worker (professional judgment) 50 mg/day, adult worker (Ref. 8)
EF	=	250 days/year for adult worker and construction worker (Ref. 8)
ED	=	1 year, construction worker (professional judgment) 25 years, adult worker (Ref. 8)
$AT_{non\text{-}carcinogenic}$	=	Exposure Duration (years) * 365 days/year for evaluating noncancer risk (Ref. 8)
$AT_{carcinogenic}$	=	70 years * 365 days/year for future adult worker and construction worker (Ref. 8)
BW	=	70 kg, adult (Ref. 8)

chemicals from surface (0-1') and subsurface soil (0-10') is a potential exposure route for future onsite workers and construction workers, respectively. The exposed skin surface areas for a future worker (onsite worker and construction worker) used to evaluate dermal contact with surface soil was based on the surface area of an adult male's hands and forearms. The values of the parameters for future workers exposed to soil onsite are listed in Table 3-10.

Based on the values in Table 3-10, the average daily intakes (DI) of soil by dermal absorption for future onsite workers are:

DI (chronic) = C x HIF (chronic) = CS (mg/kg) x ABS X 1.96E-5 (kg/kg/day)
DI (lifetime) = C x HIF (lifetime) = CS (mg/kg) x ABS x 6.99E-6 (kg/kg/day)

Based on the values in Table 3-10, the average daily intakes (DI) of soil via dermal contact for future construction workers are:

DI (chronic) = C x HIF (chronic) = CS (mg/kg) x ABS X 1.96E-5 (kg/kg/day)
DI (lifetime) = C x HIF (lifetime) = CS (mg/kg) x ABS x 2.80E-7 (kg/kg/day)

3.4.3 Uncertainties in Exposure Assessment

The estimated average daily exposure levels to chemicals of potential concern at the Chevron Orlando site were generated with a number of uncertainties. These uncertainties are generally inherent in risk assessments associated with remedial investigations particularly because of the type of and amount of data that can be collected in the short durations of sampling episodes. The most important of these uncertainties are summarized in this section as follows:

- Although current exposure levels were based on measured concentrations in the media of concern, these values are uncertain due to limited sampling and analytical variation. To account for this, the 95th percentile upper confidence limit of the mean concentration value or the maximum detected concentration was used in dose calculations. This may result in an overestimation of the actual average dose.

- Contaminant concentrations in soil and groundwater for future use were assumed to be the same as current measured concentrations, with no adjustment due to migration or dilution (in the case of groundwater), degradation, or volatilization. This may result in an overestimation of chronic or lifetime exposure for the volatile organic compounds since these

TABLE 3-10

Model for Calculating Doses from Dermal Contact with Surface and Subsurface Soil by Future Workers and Construction Workers
CHEVRON CHEMICAL COMPANY/ORTHO DIVISION
ORLANDO, ORANGE COUNTY, FLORIDA

$$\text{Soil Dermal Absorption Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

WHERE:

CS	=	Chemical concentration in soil (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
SA	=	Skin surface area available for contact (cm^2/day)
AF	=	Soil to skin adherence factor (mg/cm^2)
ABS	=	Dermal absorption factor (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

ASSUMPTIONS:

CS	=	Upper 95% confidence limit of the mean concentration in soil.
SA	=	2,000 cm^2, adult: hands and forearms (Ref. 30)
AF	=	1.0 mg/cm^2, soil adherence factor (Ref. 7).
ABS	=	0.01 - Organic compounds (Ref. 7) 0.001 - Inorganic compounds (Ref. 7)
EF	=	250 days/year, based on 5 days/week for 50 weeks (Ref. 8)
ED	=	25 years, adult worker (Ref. 8) 1 year, construction worker (professional judgment)
BW	=	70 kg., adult (Ref. 8)
$AT_{non\text{-}carcinogenic}$	=	Exposure Duration (years) * 365 days/year for evaluating noncancer risk (Ref. 8)
$AT_{carcinogenic}$	=	70 years * 365 days/year for adult worker and construction worker (Ref. 8)

may be biologically broken down or volatilized. It may also lead to anoverestimation of semi-volatile exposure, even though semi-volatiles undergo slower biological breakdown in soil and are less volatile in nature. For metals, these factors are not expected to have much of an effect on the exposure calculations, as they are typically persistent in soils. However, metals are subject to migration pathways which may reduce onsite concentrations over time.

- Sample quantitation limits for some of the media varied significantly. If a limited number of compounds are detected at an extremely high concentration, as evidenced by initial sample screening by the analytical laboratory, quantitation limits are raised. This action could result in the "masking" of other organic constituents that may be present below the raised quantitation limit. Significantly higher quantitation limits were used on some of the soil samples. Other organics may be present but could not be quantified due to the higher quantitation limit, this resulted in the compound being eliminated from further consideration in the risk assessment. This may result in an underestimation of the actual average dose.

- When deriving concentrations of chemicals, all chemicals of potential concern that were not detected in a given sample were assumed to be at one-half the quantitation limit. This may lead to an overestimation of dose.

- The air pathway was not quantitatively evaluated. This may result in an underestimation of risk.

4.0 Toxicity Assessment

4.1 Introduction

The purpose of the toxicity assessment is to assign toxicity values (criteria) to each chemical evaluated in the risk assessment. The toxicity values are used in combination with estimated doses to which a human could be exposed (as discussed in the Exposure Assessment chapter) to evaluate the potential human health risks associated with each chemical. Human health criteria developed by the EPA (cancer slope factors and reference doses) were primarily obtained from the Integrated Risk Information System (IRIS) or the 1993 Health Effects Assessment Summary Tables (HEAST). In some cases, documents from the Environmental Criteria Assessment Office (ECAO) were used to obtain criteria for chemicals which were not listed in IRIS or HEAST.

4.2 Carcinogenic and Noncarcinogenic Toxicity Values

In evaluating potential health risks, both carcinogenic and noncarcinogenic health effects must be considered. The potential for producing carcinogenic effects is limited to substances that have been shown to be carcinogenic in animals and/or humans. Excessive exposure to all substances, carcinogens and noncarcinogens, can produce adverse noncarcinogenic effects. Therefore, it is necessary to identify reference doses for every chemical selected regardless of its classification, and to identify cancer slope factors for those that are classified as carcinogenic.

4.2.1 Estimates of Carcinogenic Potency

Cancer slope factors (SFs) are developed by the EPA under the assumption that the risk of cancer from a given chemical is linearly related to dose. EPA may develop cancer slope factors from laboratory animal or epidemiological studies in which relatively high doses of the chemical were administered. It is conservatively assumed that these high doses can be extrapolated downward to extremely small doses, with some incremental risk of cancer always remaining until the dose is zero. This non-threshold theory assumes that even a small number of molecules, possibly even one uncontrolled cell division, could eventually lead to cancer. The slope factor for a chemical is usually derived by EPA using a linearized multistage model and reflects the upper-bound limit of the cancer potency of the chemical. As a result, the estimated carcinogenic risk is likely to represent a plausible upper limit to the risk.

The actual risk is unknown, but is likely to be considerably lower than the predicted risk, and may even be as low as zero.

There is some dispute as to whether the extrapolation from high to low doses is a realistic approach. It has been argued that at low doses cells may have the ability to detoxify carcinogens or repair chemical-induced cellular damage. Although it is important to recognize the possibility that some carcinogens may have a threshold for toxicity, it was assumed in the estimates of risk that no threshold exists (EPA, 1989a).

Specific carcinogenicity classifications for carcinogenic chemicals of potential concern at the Chevron site are presented in Table 4-1. Risk assessments follow the rationale used by EPA in developing these categories of classification.

Only those chemicals classified as "A" have sufficient human evidence of carcinogenicity. Carcinogens classified as "B" and "C" have insufficient human data to support their cancer-causing potential, but have varying degrees of supportive animal data. It should be noted that A, B, and C carcinogens are evaluated in risk assessments according to EPA guidance. This adds a degree of conservatism to the risk assessment since possible human carcinogens (B and C) are weighted equally in terms of total cancer risk relative to known human (A) carcinogens. Finally, it is important to note that slope factors are periodically under review by the EPA. In some cases, the EPA may withdraw the criteria until the review is completed.

4.2.2 Estimates of Carcinogenicity

The carcinogenic potency of a substance depends on its route of entry into the body (i.e., oral, inhalation, or dermal). Therefore, slope factors are developed and classified according to the administration route. In some cases, a carcinogen may produce tumors only at or near a specific route of entry (i.e., nasal passages) and may not be carcinogenic through other exposure routes. This applies to a few of the evaluated chemicals including cadmium, chromium, and nickel. Note also that EPA has not developed dermal slope factors for any carcinogens. Table 4-1 presents the cancer slope factors by exposure route. In some cases, unit risk factors $[(mg/L)^{-1}]$ or $[(mg/m^3)^{-1}]$ are used by the EPA to express cancer risk as the oral or inhalation unit risk per liter or cubic meter. To convert the unit risk factors to units of $(mg/kg\text{-}day)^{-1}$, which are complementary to exposure dose calculated as mg/kg-day, the unit risk factor is adjusted by the assumptions that 2 liters of water are consumed per day or

Table 4-1
Chemical-Specific Toxicity Values
Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	Ingestion Exposures: Oral Slope Factor (SF) mg/kg day	Wt of Ev	Oral Reference Dose (RfD) mg/kg day	Ref	Target Organ or System
1,4-Dichlorobenzene	2.4E-02	C		H	GI tract
2-Methylnaphthalene			3.0E-02		GI tract
2,4-Dimethylphenol			2.0E-02	I	
4,4'-DDD	2.4E-01	B2		I	
4,4'-DDE	3.4E-01	B2		I	liver,CNS
4,4'-DDT	3.4E-01	B2	5.0E-04	I	fetotoxic, liver
Aldrin	1.7E+01	B2	3.0E-05	I	liver
Alpha-BHC	6.3E+00	B2		I	liver
Arochlor-1260	7.7E+00	B2		I	blood, liver
Arsenic	1.8E+00	A	3.0E-04	C/I	increased BP
Benzene	2.9E-02	A		I	stomach/nasal
Beta-BHC	1.8E+00	C		I	liver
Chlordane	1.3E+00	B2	6.0E-05	I	liver
Chlorobenzene		D	2.0E-02	I	liver,kidney
Delta-BHC				I	liver,kidney
Dieldrin	1.6E+01	B2	5.0E-05	I	liver
Di-n-Butylphthalate		D	1.0E-01	I	liver,kidney,blood
Endrin		D	3.0E-04	I	
Ethylbenzene		D	1.0E-01	I	lung/liver,RBCs
Fenthion					
Heptachlor Epoxide	9.1E+00	B2	1.3E-05	I	kidney
Lead		B2			
Lindane (Gamma-BHC)	1.3E+00	B2	3.0E-04	I	liver, kidney
Naphthalene		D	4.0E-02	I	splenic capsule
Xylene (mixed)		D	2.0E+00	I	fetotoxic

NOTES:

I - Integrated Risk Information System

H - Health Effects Assessment Summary Tables

H2 - Health Effects Assessment Summary Tables, table 2

A - Predicted value listed in "EPA Research and Development, Interim Guidance for Dermal Exposure Assessment," March, 1991

B - Modeled value listed in "EPA Research and Development, Interim Guidance for Dermal Exposure Assessment," March, 1991

C - Value based on unit risk

D - Reference: EPA, 1992a

E - EPA Environmental Criteria Assessment Office, provisional value

RfD = Reference Dose RfC = Reference Concentration

WT OF EV = Weight of Evidence Classification

Table 4-1 (cont'd)
Chemical-Specific Toxicity Values
Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	Inhalation Exposures: Inhalation Slope Factor (SF) kg day/mg	Wt of ev	Reference Conc. (RfC) mg/cu m	Inhalation RfD Converted from RfC mg/kg day	Ref	Volatilization Rate	Target Organ or System
1,4-Dichlorobenzene		C	8.0E-01	2.3E-01	H	2.00E-01	NA/liver, kidney
2-Methylnaphthalene						1.00E-01	
4,4'-DDD						1.00E-01	
4,4'-DDE		B2			H	1.00E-01	NA
4,4'-DDT	3.4E-01	B2			H	1.00E-01	liver
Aldrin	1.7E+01	B2			I	1.00E-01	liver
Alpha-BHC	6.3E+00	B2			I	1.00E-01	NA
Arochlor-1260		B2			H	1.00E-01	NA
Arsenic	5.0E+01	A			H	0.00E+00	respiratory tract
Benzene	2.9E-02	A	2.0E-03	1.7E-03	E	1.00E+00	leukemia
Beta-BHC	1.8E+00	C			I	1.00E-01	NA
Chlordane	1.3E+00	B2	5.0E+01		H	1.00E-01	
Chlorobenzene		D	2.0E-02	5.7E-03		1.00E+00	liver, kidney
Delta-BHC						1.00E-01	
Dieldrin	1.6E+01	B2			H	1.00E-01	liver
Di-n-Butylphthalate						1.00E-01	
Endrin							
Ethylbenzene			1.0E+00	2.9E-01		1.00E+00	
Fenthion							
Heptachlor Epoxide	9.1E+00	B2			H	1.00E-01	liver
Lead						0.00E+00	
Lindane (Gamma-BHC)		B2			H	1.00E-01	
Naphthalene						1.00E-01	
Xylene (mixed)				2.0E+00	D	1.00E+00	CNS, nose, throat

NOTES:

I - Integrated Risk Information System

H - Health Effects Assessment Summary Tables

H2 - Health Effects Assessment Summary Tables, table 2

A - Predicted value listed in "EPA Research and Development, Interim Guidance for Dermal Exposure Assessment," March, 1991

B - Modeled value listed in "EPA Research and Development, Interim Guidance for Dermal Exposure Assessment," March, 1991

C - Value based on unit risk

D - Reference: EPA, 1992a

E - EPA Environmental Criteria Assessment Office, provisional value

RfD = Reference Dose RfC = Reference Concentration

WT OF EV = Weight of Evidence Classification

Table 4-1 (cont'd)
Chemical-Specific Toxicity Values
Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	Dermal Exposures: Oral Absorption Effeciency percent	Oral Absorption Effeciency Reference	Dermal Extrapolated Reference Dose (RfD) mg/kg day	Dermal Extrapolated Slope Factor (SF) kg day/mg	Soil Absorp-tion Factor (unitless)	Ref
1,4-Dichlorobenzene	1.0E+02	ATSDR, 1987		2.4E-02	1.0E-02	D
2-Methylnaphthalene	5.0E+01	D	1.5E-02		1.0E-02	D
4,4'-DDD	5.0E+01	D		4.8E-01	1.0E-02	D
4,4'-DDE	5.0E+01	D		6.8E-01	1.0E-02	D
4,4'-DDT	5.0E+01	D	2.5E-04	6.8E-01	1.0E-02	D
Aldrin	5.0E+01	D	1.5E-05	3.4E+01	1.0E-02	D
Alpha-BHC	5.0E+01	D		1.3E+01	1.0E-02	D
Arochlor-1260	9.0E+01	ATSDR, 1987		8.6E+00	1.0E-02	D
Arsenic	9.5E+01	ATSDR, 1987	2.9E-04	1.8E+00	1.0E-03	D
Benzene	9.0E+01	ATSDR, 1987		3.2E-02	1.0E-02	D
Beta-BHC	5.0E+01	D		3.6E+00	1.0E-02	D
Chlordane	5.0E+01	D	3.0E-05	2.6E+00	1.0E-02	D
Chlorobenzene	3.1E+01	ATSDR, 1989	6.2E-03		1.0E-02	D
Delta-BHC	5.0E+01	D			1.0E-02	D
Dieldrin	5.0E+01	D	2.5E-05	3.2E+01	1.0E-02	D
Di-n-Butylphthalate	9.7E+01	ATSDR, 1989	9.7E-02		1.0E-02	D
Endrin	5.0E+01	D	1.5E-04			
Ethylbenzene	9.2E+01	ATSDR, 1989	9.2E-02		1.0E-02	D
Fenthion						
Heptachlor Epoxide	1.0E+02	ATSDR, 1987	1.3E-05	9.1E+00	1.0E-02	D
Lead	1.5E+01	ATSDR,88 Adult			1.0E-03	D
Lindane (Gamma-BHC)	5.0E+01	D	1.5E-04	2.6E+00	1.0E-02	D
Naphthalene	5.0E+01	D	2.0E-02		1.0E-02	D
Xylene (mixed)	9.2E+01	ATSDR, 1989	1.8E+00		1.0E-02	D

NOTES:

I - Integrated Risk Information System

H - Health Effects Assessment Summary Tables

H2 - Health Effects Assessment Summary Tables, table 2

A - Predicted value listed in "EPA Research and Development, Interim Guidance for Dermal Exposure Assessment," March, 1991

B - Modeled value listed in "EPA Research and Development, Interim Guidance for Dermal Exposure Assessment," March, 1991

C - Value based on unit risk

D - Reference: EPA, 1992a

E - EPA Environmental Criteria Assessment Office, provisional value

RfD = Reference Dose RfC = Reference Concentration

WT OF EV = Weight of Evidence Classification

20 m^3 of air are inhaled per day, respectively, and that the human body weight is 70 kg.

4.2.2.1 Oral. Oral slope factors are used to evaluate the risk from exposure to potential carcinogens through oral exposure pathways such as, incidental ingestion of soil and groundwater ingestion. Slope factors were available for all carcinogens except lead.

4.2.2.2 Inhalation. Inhalation slope factors are used to evaluate the risk from exposure to potential carcinogens through inhalation exposure pathways such as the inhalation of volatile chemicals from groundwater while showering.

4.2.2.3 Dermal. Dermal slope factors are not available from the EPA, but it was assumed that chemicals which are carcinogenic orally will also produce cancer by dermal exposure. In the absence of dermal slope factors, the oral slope factor is divided by an appropriate gastrointestinal (GI) absorption factor. This adjusts the dermal dose for the amount absorbed since dermal exposure doses are expressed as "absorbed" doses (note that oral and inhalation doses are usually expressed as "administered" doses). Oral slope factors are normally developed from long-term studies where a substance is administered orally to laboratory animals. Depending on the form in which the chemical is administered, the relative absorption of the chemical through the gastrointestinal tract (and therefore the relative absorption factor) may vary considerably. Volatile organic compounds tend to be more readily absorbed through the GI tract than semivolatile organic compounds. Therefore, an absorption factor of 80 percent was used for all volatile organic compounds and an absorption factor of 50 percent was used for semivolatile compounds, when chemical-specific absorbtion factors were not available. These values correspond to the default values suggested by EPA Region IV for cases in which the GI absorption of a substance is not known. Metals in general, tend to be poorly absorbed through the GI tract. However, absorption is highly dependent on the water and lipid solubility of the specific chemical form(s) in which it is present. When chemical specific information was not available, an absorption factor of 20 percent was used for inorganics (metals). This value corresponds to the default value suggested by EPA Region IV for cases in which the GI absorption of a substance is not known.

4.2.3 Estimates of Noncarcinogenic Toxicity

Toxicity criteria used to evaluate potential noncarcinogenic health effects are termed reference doses (RfDs). Unlike the approach used in evaluating carcinogenic risk, it is assumed in developing RfDs that a threshold dose exists below which there is no potential for human toxicity. The term RfD was developed by the EPA to refer to the daily intake of a chemical to which an individual can be exposed without any expectation of noncarcinogenic effects occurring during a given exposure period (i.e., organ damage, biochemical alterations, birth defects). The RfD is derived from a no-observed-adverse-effect level (NOAEL) or lowest-observed-adverse-effect level (LOAEL) obtained from human or animal studies by the application of standard order-of-magnitude uncertainty factors, and in certain cases, an additional modifying factor to account for professional assessment of scientific uncertainties in the available data.

A NOAEL is that dose of chemical at which no toxic effects are observed in any of the test subjects or animals. The study chosen to establish the NOAEL is based on the criterion that the measured toxic endpoint represents the most sensitive ("critical") target organ or tissue to that chemical (i.e., that target organ or tissue that shows evidence of damage at the lowest dose). Since many chemicals can produce toxic effects on several organ systems, with each toxic effect possibly having a separate threshold dose, the distinction of the critical toxic effect provides added confidence that the NOAEL is protective of health. In contrast to a NOAEL, a LOAEL is the lowest dose at which the most sensitive toxic effect is observed in any of the test subjects or animals. If a LOAEL is used in place of a NOAEL to derive a RfD, an additional level of uncertainty is involved and, therefore, an additional order-of-magnitude uncertainty factor is applied.

A variety of regulatory agencies have used the threshold approach for noncarcinogenic substances in the development of health effects criteria, such as worker-related threshold limit values (TLVs), air quality standards, and food additive and drinking water regulations. Chronic RfDs have been developed for the oral and inhalation routes, but not for the dermal route. As with carcinogenicity classification, human data are used preferentially if they are deemed adequate through scientific evaluation. However, in many cases, adequate human toxicity data are not available and animal studies have to be used. In cases where no RfD value is available, RfCs can be utilized. To convert the RfC value to units of $(mg/kg\text{-}day)^{-1}$, which are

complementary to exposure dose calculated as mg/kg-day, the RfC is adjusted by the assumptions that 20 m^3 of air are inhaled per day and that human body weight is 70 kg.

4.2.4 Reference Doses

Table 4-1 presents the route-specific RfDs. Specific consideration was given to the following items:

4.2.4.1 Oral. Chronic RfDs were available for most chemicals of potential concern at the Chevron site. Several chemicals of potential concern do not currently have published oral RfD values. These chemicals were 1,4-dichlorobenzene, 2-methylnaphthalene, 4,4-DDD, 4,4-DDE, alpha-BHC, arochlor-1260, benzene, beta-BHC, delta-BHC, fenthion, and lead. These chemicals will not be quantitatively evaluated in the BRA.

4.2.4.2 Inhalation. Inhalation RfDs are used to evaluate the risk from exposure to potential contaminants through the inhalation exposure pathway such as the inhalation of volatile chemicals from groundwater while showering. As recommended by EPA Region IV for volatile organic compounds, oral RfDs were used as inhalation RfDs if none were available from IRIS or HEAST. This procedure assumes that an organic chemical producing noncarcinogenic effects by the oral route is likely to produce the same effect through systemic absorption following inhalation and that the extent of systemic absorption is comparable through both exposure routes. Because the most sensitive effects of metals through the inhalation route are usually localized (i.e., on the respiratory tract), the route-specific oral RfDs for metals were not used as default inhalation values.

4.2.4.3 Dermal. As in the case of cancer slope factors, no RfDs have been developed by EPA for the dermal route. Therefore, dermal RfDs were derived for the chemicals of potential concern in accordance with EPA guidelines. A chronic dermal RfD was derived for each chemical by multiplying the value used as the chronic oral RfD by an appropriate GI absorption factor. The approach used to select the absorption factor was the same as that previously described for cancer slope factors. If chemical-specific absorbtion factors were not available, the following absorption factors were substituted: 80 percent for volatile organics, 50 percent for semivolatile organics, and 20 percent for metals.

4.3 Uncertainties in Toxicological Prediction of Health Effects

The prediction of human health consequences likely to occur following exposure to a given dose of a chemical is imprecise due to many uncertainties in the toxicological information available on dose-response relationships.

The quantity of toxicity information for the chemicals evaluated in the risk assessment is typically limited, with correspondingly varying degrees of uncertainty associated with the calculated toxicity values. Sources of uncertainty associated with the toxicity values may include (EPA, 1989a):

- Using dose-response information from effects observed at high doses to predict the adverse health effects that may occur following exposure to the low levels expected from human contact with the agent in the environment.
- Using dose-response information from short-term exposure studies to predict the effects of long-term exposures, and vice-versa.
- Using dose-response information from animal studies to predict effects in human.
- Using dose-response information for individual chemicals, when in fact mixtures of chemicals may react differently than single species. Chemical interaction of mixtures may be more toxic.

Site-specific uncertainties include:

- Not assessing risks for chemicals without critical toxicity values.
- Using route-to-route extrapolation to calculate dermal risks

5.0 Risk Characterization

The objective of the risk characterization is to integrate the exposure and toxicity assessments into quantitative and qualitative expressions of risk. A detailed risk characterization is presented in this section.

5.1 Introduction

The risk characterization is an evaluation of the nature and degree of potential carcinogenic and noncarcinogenic health risks posed to current and hypothetical future receptors at the Chevron Orlando site. The pathways of exposure are described in Section 3. Human health risks for carcinogenic and noncarcinogenic effects are discussed independently because of the different toxicological endpoints, relevant exposure durations, and methods employed in characterizing risk. The potential for carcinogenic effects is limited to exposure to only those chemicals classified as carcinogens, while both carcinogenic and noncarcinogenic chemicals are evaluated for potential noncarcinogenic effects.

Carcinogenic and noncarcinogenic risks were evaluated for each exposure pathway and scenario by integrating the exposure doses calculated in Section 3 (Exposure Assessment) with the toxicity criteria for the chemicals of potential concern determined in Section 4 (Toxicity Assessment). The evaluation of carcinogenic risks are summarized in Subsection 5.2, and the evaluation of noncarcinogenic risks are summarized in Subsection 5.3. Uncertainties in the risk characterization are discussed in Subsection 5.4.

The risk characterization tables (5-1 through 5-18) present the exposure assessment results as well as the quantification of risks. Each table presents the exposure assumptions and formulas used to generate the human intake factors and risks for both noncarcinogenic and carcinogenic risks. The "Human Intake Factor" (HIF) is generated from the formula and assumptions presented at the bottom of each table. The RfDs, SFs, and PCs came from Table 4-1. The formulas used to generate noncarcinogenic and carcinogenic risks are also presented at the bottom of each table. The risks from each chemical are summed to yield the final pathway risks. The pathway risks are summed in Tables 5-19 and 5-20.

Table 5-1
Incidental Ingestion of Onsite Surface Soil (0 - 1')
Onsite Adolescent (ages 7-16)
(Current/Future Trespasser Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral RfD mg/kg-day	Hazard Quotent (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral Slope Factor kg-day/mg	Risk unitless
4,4'-DDD	2.5E+00	6.1E-07	1.5E-06			8.7E-08	2.2E-07	2.4E-01	5.2E-08
4,4'-DDE	1.1E+00	6.1E-07	6.7E-07			8.7E-08	9.6E-08	3.4E-01	3.3E-08
4,4'-DDT	1.4E+00	6.1E-07	8.5E-07	5.0E-04	1.7E-03	8.7E-08	1.2E-07	3.4E-01	4.1E-08
Aldrin	1.2E+00	6.1E-07	7.3E-07	3.0E-05	2.4E-02	8.7E-08	1.0E-07	1.7E+01	1.8E-06
Beta-BHC	1.1E+00	6.1E-07	6.7E-07			8.7E-08	9.6E-08	1.8E+00	1.7E-07
Chlordane	8.6E+00	6.1E-07	5.2E-06	6.0E-05	8.7E-02	8.7E-08	7.5E-07	1.3E+00	9.7E-07
Heptachlor epoxide	6.0E-01	6.1E-07	3.7E-07	1.3E-05	2.8E-02	8.7E-08	5.2E-08	9.1E+00	4.7E-07
Dieldrin	1.2E+00	6.1E-07	7.3E-07	5.0E-05	1.5E-02	8.7E-08	1.0E-07	1.6E+01	1.7E-06
		Total Pathway Hazard Index------->			2E-01	Total Pathway Risk---->			5E-06

INCIDENTAL INGESTION OF SOIL

CS = Concentration of chemical in soil (mg/kg)

1.0E-06 CF = 0.000001 kg/mg - Conversion Factor, (EPA, 1989a)

1.0E+02 IR = 100 mg/day - Ingestion Rate of soil by an adolescent (7-16 yrs.), (EPA, 1992a)

1.0E+01 ED = 10 yrs - Exposure Duration for an adolescent (7-16 yrs), (EPA, 1992a)

1.0E+02 EF = 100 days/yr - Exposure Frequency for an adolescent (7-16 yrs), (EPA, 1992a)

4.5E+01 BW = 45 kg - Body Weight for an adolescent (7-16 yrs), (EPA, 1992a)

1.0E+01 ATN = 10 yrs - Averaging Time for non-carcinogenic compounds, EPA, 1992a)

7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)

HIF--NON-CARCINOGENIC---------> 6.1E-07 HIF = (IR * EF * ED / BW)*CF / (ATN)(365)

HIF--CARCINOGENIC----------> 8.7E-08 HIF = (IR * EF * ED / BW)*CF / (ATC)(365)

DAILY INTAKE = (CS * HIF)

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-2
Dermal Contact with Onsite Surface Soil (0 - 1')
Onsite Adolescent (ages 7-16)
(Current/Future Trespasser Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Absorption Factor (ABS) unitless	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal RfD mg/kg-day	Hazard Quotent (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal Slope Factor kg-day/mg	Risk unitless
4,4'-DDD	2.5E+00	1.0E-02	3.2E-05	8.1E-07			4.6E-06	1.2E-07	4.8E-01	5.5E-08
4,4'-DDE	1.1E+00	1.0E-02	3.2E-05	3.5E-07			4.6E-06	5.1E-08	6.8E-01	3.4E-08
4,4'-DDT	1.4E+00	1.0E-02	3.2E-05	4.5E-07	2.5E-04	1.8E-03	4.6E-06	6.5E-08	6.8E-01	4.4E-08
Aldrin	1.2E+00	1.0E-02	3.2E-05	3.9E-07	1.5E-05	2.6E-02	4.6E-06	5.5E-08	3.4E+01	1.9E-06
Beta-BHC	1.1E+00	1.0E-02	3.2E-05	3.5E-07			4.6E-06	5.1E-08	3.6E+00	1.8E-07
Chlordane	8.6E+00	1.0E-02	3.2E-05	2.8E-06	3.0E-05	9.3E-02	4.6E-06	4.0E-07	2.6E+00	1.0E-06
Heptachlor epoxide	6.0E-01	1.0E-02	3.2E-05	1.9E-07	9.1E+00	2.1E-08	4.6E-06	2.8E-08	1.3E-05	3.6E-13
Dieldrin	1.2E+00	1.0E-02	3.2E-05	3.9E-07	2.5E-05	1.5E-02	4.6E-06	5.5E-08	3.2E+01	1.8E-06
NA - Data Not Available			Total Pathway Hazard Index------->			1E-01	Total Pathway Risk----->			5E-06

DERMAL CONTACT WITH SOIL
CS = Concentration of chemical in soil (mg/kg)
ABS = Absorption Factor - Assumed to be 0.01 for organics and 0.001 for inorganics

1.0E-06 CF = 0.000001 kg/mg - Conversion Factor, (EPA, 1989a)
5.3E+03 SA = 5300 sq cm - Skin Surface Area, (Adolescent), hands, arms, and lower legs (OSWER, 1991)
1.0E+02 EF = 100 days/yr - Exposure Frequency, (Adolescent 7-16 yrs.), (EPA, 1992a)
1.0E+01 ED = 10 yrs - Exposure Duration for adolescent (7-16 yrs.), (EPA, 1992a)
4.5E+01 BW = 45 kg - Body Weight for adolescent, (7-16 yrs.), (EPA, 1992a)
1.0E+01 ATN = 10 yrs - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)
7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)
1.0E+00 AF = 1.00 mg/sq cm - Adherence Factor, (EPA, Region X)

HIF--NON-CARCINOGENIC----------> 3.2E-05 HIF = [(SA * EF * ED * AF / BW) * CF / (ATN)(365)]
HIF--CARCINOGENIC----------> 4.6E-06 HIF = [(SA * EF * ED * AF / BW) * CF / (ATC)(365)]

DAILY INTAKE = (CS * ABS * HIF)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-3
Incidental Ingestion of Offsite Surface Soil (0 - 1')
Offsite Adult
(Current/Future Residential Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral RfD mg/kg-day	Hazard Quotent (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral Slope Factor kg-day/mg	Risk unitless
Chlordane	3.9E+00	1.4E-06	5.5E-06	6.0E-05	9.2E-02	4.7E-07	1.8E-06	1.3E+00	2.4E-06
Dieldrin	6.6E-02	1.4E-06	9.2E-08	5.0E-05	1.8E-03	4.7E-07	3.1E-08	1.6E+01	5.0E-07
Lead	1.3E-01	1.4E-06	1.8E-07			4.7E-07	6.1E-08		
		Total Pathway Hazard Index------->			9E-02	Total Pathway Risk---->			3E-06

INCIDENTAL INGESTION OF SOIL

CS = Concentration of chemical in soil (mg/kg)

1.0E-06 CF = 0.000001 kg/mg - Conversion Factor, (EPA, 1989a)

1.0E+02 IRA = 100 mg/day - Ingestion Rate of soil by an adult (7-30 yrs.), (OSWER, 1991)

2.4E+01 EDA = 24 yrs - Exposure Duration for an adult (7-30 yrs), (OSWER, 1991)

3.5E+02 EFA = 350 days/yr - Exposure Frequency for an adult (7-30 yrs), (OSWER, 1991)

7.0E+01 BWA = 70 kg - Body Weight for adult, (OSWER, 1991)

2.4E+01 ATN = 24 yrs - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)

7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)

HIF--NON-CARCINOGENIC-------> 1.4E-06 HIF = (IRA * EFA * EDA / BWA)*CF / (ATN)(365)

HIF--CARCINOGENIC-------> 4.7E-07 HIF = (IRA * EFA * EDA / BWA)*CF / (ATC)(365)

DAILY INTAKE = (CS * HIF)

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-4
Dermal Contact with Offsite Surface Soil (0 - 1')
Offsite Adult
(Current/Future Residential Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Absorption Factor (ABS) unitless	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal RfD mg/kg-day	Hazard Quotent (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal Slope Factor kg-day/mg	Risk unitless
Chlordane	3.9E+00	1.0E-02	7.3E-05	2.8E-06	3.0E-05	9.4E-02	2.5E-05	9.7E-07	2.6E+00	2.5E-06
Dieldrin	6.6E-02	1.0E-02	7.3E-05	4.8E-08	2.5E-05	1.9E-03	2.5E-05	1.6E-08	3.2E+01	5.3E-07
Lead	1.3E-01	1.0E-03	7.3E-05	9.4E-09			2.5E-05	3.2E-09		
			Total Pathway Hazard Index------->			1E-01	Total Pathway Risk---->			3E-06

DERMAL CONTACT WITH SOIL

CS = Concentration of chemical in soil (mg/kg)

ABS = Absorption Factor - Assumed to be 0.25 for volatiles, 0.1 for semi-volatiles, 0.01 for metals (Ryan, 1987), and 0.60 for ordnance compounds

1.0E-06 CF = 0.000001 kg/mg - Conversion Factor, (EPA, 1989a)

5.3E+03 SAA = 5300 sq cm - Skin Surface Area Available, (Adult), hands, arms, lower legs (OSWER, 1991)

3.5E+02 EFA = 350 days/yr - Exposure Frequency, (Adult: 7-30 yrs.), (OSWER, 1991)

2.4E+01 EDA = 24 yrs - Exposure Duration for adult (7-30 yrs.), (OSWER, 1991)

7.0E+01 BWA = 70 kg - Body Weight for adult, (OSWER, 1991)

2.4E+01 ATN = 24 yrs - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)

7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)

1.0E+00 AF = 1.00 mg/sq cm - Adherence Factor, (EPA, Region X)

HIF--NON-CARCINOGENIC-------> 7.3E-05 HIF = [(SAA * EFA * EDA * AF / BWA) * CF / (ATN)(365)]

HIF--CARCINOGENIC-------> 2.5E-05 HIF = [(SAA * EFA * EDA * AF / BWA) * CF / (ATC)(365)]

DAILY INTAKE = (CS * ABS * HIF)

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-5
Incidental Ingestion of Offsite Surface Soil (0 - 1')
Offsite Child (age 1 - 6)
(Current/Future Residential Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral RfD mg/kg-day	Hazard Quotent (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral Slope Factor kg-day/mg	Risk unitless
Chlordane	3.9E+00	1.3E-05	5.0E-05	6.0E-05	8.3E-01	1.1E-06	4.3E-06	1.3E+00	5.6E-06
Dieldrin	6.6E-02	1.3E-05	8.6E-07	5.0E-05	1.7E-02	1.1E-06	7.2E-08	1.6E+01	1.2E-06
Lead	1.3E-01	1.3E-05	1.7E-06			1.1E-06	1.4E-07		
		Total Pathway Hazard Index-------->			8E-01	Total Pathway Risk---->			7E-06

INCIDENTAL INGESTION OF SOIL

CS = Concentration of chemical in soil (mg/kg)

1.0E-06 CF = 0.000001 kg/mg - Conversion Factor, (EPA, 1989a)

2.0E+02 IRC = 200 mg/day - Ingestion Rate of soil by a child (1-6 yrs.), (OSWER, 1991)

6.0E+00 EDC = 6 yrs - Exposure Duration for a child (1-6 yrs), (OSWER, 1991)

3.5E+02 EFC = 350 days/yr - Exposure Frequency for a child (1-6 yrs), (OSWER, 1991)

1.5E+01 BWC = 15 kg - Body Weight for a child (1-6 yrs), (OSWER, 1991)

6.0E+00 ATN = 6 yrs - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)

7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)

HIF--NON-CARCINOGENIC----------> 1.3E-05 HIF =((IRC * EFC * EDC / BWC)*CF / (ATN)(365)

HIF--CARCINOGENIC----------> 1.1E-06 HIF = (IRC * EFC * EDC / BWC)*CF / (ATC)(365)

DAILY INTAKE = (CS * HIF)

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-6
Dermal Contact with Offsite Surface Soil (0 - 1')
Offsite Child (age 1 - 6)
(Current/Future Residential Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Absorption Factor (ABS) unitless	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal RfD mg/kg-day	Hazard Quotent (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal Slope Factor kg-day/mg	Risk unitless
Chlordane	3.9E+00	1.0E-02	2.0E-04	7.9E-06	3.0E-05	2.6E-01	1.7E-05	6.8E-07	2.6E+00	1.8E-06
Dieldrin	6.6E-02	1.0E-02	2.0E-04	1.3E-07	2.5E-05	5.3E-03	1.7E-05	1.1E-08	3.2E+01	3.7E-07
Lead	1.3E-01	1.0E-03	2.0E-04	2.6E-08			1.7E-05	2.3E-09		
			Total Pathway Hazard Index-------->			3E-01		Total Pathway Risk---->		2E-06

DERMAL CONTACT WITH SOIL

CS = Concentration of chemical in soil (mg/kg)

ABS = Absorption Factor - Assumed to be 0.25 for volatiles, 0.1 for semi-volatiles, 0.01 for metals (Ryan, 1987), and 0.60 for ordnance compounds

1.0E-06 CF = 0.000001 kg/mg - Conversion Factor, (EPA, 1989a)

3.2E+03 SAC = 3160 sq cm - Skin Surface Area Available (Child 1-6 yrs.), hands, arms, legs (OSWER, 1991)

3.5E+02 EFC = 350 days/yr - Exposure Frequency, (Child: 1-6 yrs.) (OSWER, 1991)

6.0E+00 EDC = 6 yrs - Duration for child (1-6 yrs.), (OSWER, 1991)

1.5E+01 BWC = 15 kg - Body Weight for a child (1-6 yrs.), (OSWER, 1991)

6.0E+00 ATN = 6 yrs - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)

7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)

1.0E+00 AF = 1.00 mg/sq cm - Adherence Factor, (EPA, 1992a)

HIF--NON-CARCINOGENIC----------> 2.0E-04 HIF = [(SAC * EFC * EDC * AF / BWC) * CF / (ATN)(365)]

HIF--CARCINOGENIC----------> 1.7E-05 HIF = [(SAC * EFC * EDC * AF / BWC) * CF / (ATC)(365)]

DAILY INTAKE = (CS * ABS * HIF)

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-7
Incidental Ingestion of Onsite Surface Soil (0 - 1')
Onsite Adult
(Future Worker Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral RfD mg/kg-day	Hazard Quotient (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral Slope Factor kg-day/mg	Risk unitless
4,4'-DDD	2.5E+00	4.9E-07	1.2E-06			1.7E-07	4.4E-07	2.4E-01	1.0E-07
4,4'-DDE	1.1E+00	4.9E-07	5.4E-07			1.7E-07	1.9E-07	3.4E-01	6.5E-08
4,4'-DDT	1.4E+00	4.9E-07	6.8E-07	5.0E-04	1.4E-03	1.7E-07	2.4E-07	3.4E-01	8.3E-08
Aldrin	1.2E+00	4.9E-07	5.9E-07	3.0E-05	2.0E-02	1.7E-07	2.1E-07	1.7E+01	3.6E-06
Beta-BHC	1.1E+00	4.9E-07	5.4E-07			1.7E-07	1.9E-07	1.8E+00	3.5E-07
Chlordane	8.6E+00	4.9E-07	4.2E-06	6.0E-05	7.0E-02	1.7E-07	1.5E-06	1.3E+00	2.0E-06
Dieldrin	1.2E+00	4.9E-07	5.9E-07	5.0E-05	1.2E-02	1.7E-07	2.1E-07	1.6E+01	3.4E-06
Heptachlor epoxide	6.0E-01	4.9E-07	2.9E-07	1.3E-05	2.3E-02	1.7E-07	1.0E-07		
		Total Pathway Hazard Index------->			1E-01	Total Pathway Risk----->			9E-06

INCIDENTAL INGESTION OF SOIL

CS = Concentration of chemical in soil (mg/kg)

- Assumed Value

1.0E-06 CF = 0.000001 kg/mg - Conversion Factor, (EPA, 1989a)

5.0E+01 IR = 50 mg/day - Ingestion Rate of soil by an adult worker, (OSWER, 1991)

2.5E+01 ED = 25 yrs - Exposure Duration for an adult worker, (OSWER, 1991)

2.5E+02 EF = 250 days/yr - Exposure Frequency for an adult worker (5 days/wk for 50 wks) #

7.0E+01 BW = 70 kg - Body Weight for adult worker, (OSWER, 1991)

2.5E+01 ATN = 25 yrs - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)

7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)

HIF--NON-CARCINOGENIC---------> 4.9E-07 HIF = ((CF * IR * ED * EF / BW)) / (ATN)(365)

HIF--CARCINOGENIC---------> 1.7E-07 HIF = ((CF * IR * ED * EF / BW)) / (ATC)(365)

DAILY INTAKE = (CS * HIF)

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-8
Dermal Contact with Onsite Surface Soil (0 - 1')
Onsite Adult
(Future Worker Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Absorption Factor (ABS) unitless	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal RfD mg/kg-day	Hazard Quotient (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal Slope Factor kg-day/mg	Risk unitless
4,4'-DDD	2.5E+00	1.0E-02	2.0E-05	4.9E-07			7.0E-06	1.7E-07	4.8E-01	8.4E-08
4,4'-DDE	1.1E+00	1.0E-02	2.0E-05	2.2E-07			7.0E-06	7.7E-08	6.8E-01	5.2E-08
4,4'-DDT	1.4E+00	1.0E-02	2.0E-05	2.7E-07	2.5E-04	1.1E-03	7.0E-06	9.8E-08	6.8E-01	6.7E-08
Aldrin	1.2E+00	1.0E-02	2.0E-05	2.3E-07	1.5E-05	1.6E-02	7.0E-06	8.4E-08	3.4E+01	2.9E-06
Beta-BHC	1.1E+00	1.0E-02	2.0E-05	2.2E-07			7.0E-06	7.7E-08	3.6E+00	2.8E-07
Chlordane	8.6E+00	1.0E-02	2.0E-05	1.7E-06	3.0E-05	5.6E-02	7.0E-06	6.0E-07	2.6E+00	1.6E-06
Dieldrin	1.2E+00	1.0E-02	2.0E-05	2.3E-07	2.5E-05	9.4E-03	7.0E-06	8.4E-08	3.2E+01	2.7E-06
Heptachlor epoxide	6.0E-01	1.0E-02	2.0E-05	1.2E-07	1.3E-05	9.0E-03	7.0E-06	4.2E-08	9.1E+00	3.8E-07
			Total Pathway Hazard Index------->			8E-02		Total Pathway Risk---->		8E-06

DERMAL CONTACT WITH SOIL
CS = Concentration of chemical in soil (mg/kg)
ABS = Absorption Factor - Assumed to be 0.01 for organics and 0.001 for inorganics

- Assumed Value

1.0E-06 CF = 0.000001 kg/mg - Conversion Facor, (EPA, 1989a)
2.0E+03 SA = 2000 sq cm - Skin Surface Area Available for Contact, hands and forearms, (EPA, 1989d)
2.5E+02 EF = 250 days/yr - Exposure Frequency for an adult worker (5 days/wk for 50 wks) #
2.5E+01 ED = 25 yrs - Exposure Duration for adult worker, (OSWER, 1991)
7.0E+01 BW = 70 kg - Body Weight for adult worker, (OSWER, 1991)
2.5E+01 ATN = 25 yrs - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)
7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)
1.0E+00 AF = 1.00 mg/sq cm - Adherence Factor, (EPA, Region X)

HIF--NON-CARCINOGENIC----------> 2.0E-05 HIF = (CF * SA * EF * ED * AF / BW)) / (ATN)(365)]
HIF-CARCINOGENIC----------> 7.0E-06 HIF = (CF * SA * EF * ED * AF / BW)) / (ATC)(365)]

DAILY INTAKE = (CS * ABS * HIF)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-9
Incidental Ingestion of Onsite Subsurface Soil (0-10')
Onsite Adult
(Future Construction Worker Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral RfD mg/kg-day	Hazard Quotient (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral Slope Factor kg-day/mg	Risk unitless
4,4'-DDD	1.7E+01	2.0E-06	3.3E-05			2.8E-08	4.8E-07	2.4E-01	1.1E-07
4,4'-DDE	2.1E+00	2.0E-06	4.2E-06			2.8E-08	5.9E-08	3.4E-01	2.0E-08
4,4'-DDT	2.7E+00	2.0E-06	5.4E-06	5.0E-04	1.1E-02	2.8E-08	7.6E-08	3.4E-01	2.6E-08
Aldrin	1.5E+00	2.0E-06	3.0E-06	3.0E-05	1.0E-01	2.8E-08	4.2E-08	1.7E+01	7.1E-07
Alpha-BHC	1.4E+00	2.0E-06	2.8E-06			2.8E-08	3.9E-08	6.3E+00	2.5E-07
Beta-BHC	1.2E+00	2.0E-06	2.3E-06			2.8E-08	3.4E-08	1.8E+00	6.0E-08
Chlordane	4.6E+01	2.0E-06	9.2E-05	6.0E-05	1.5E+00	2.8E-08	1.3E-06	1.3E+00	1.7E-06
Dieldrin	2.0E+00	2.0E-06	4.0E-06	5.0E-05	8.0E-02	2.8E-08	5.6E-08	1.6E+01	9.0E-07
Lindane (Gamma-BHC)	1.4E+00	2.0E-06	2.8E-06	3.0E-04	9.3E-03	2.8E-08	3.9E-08	1.3E+00	5.1E-08
Endrin	6.7E+00	2.0E-06	1.3E-05	3.0E-04	4.5E-02	2.8E-08	1.9E-07		
		Total Pathway Hazard Index------->			2E+00	Total Pathway Risk---->			4E-06

INCIDENTAL INGESTION OF SOIL

CS = Concentration of chemical in soil (mg/kg)

- Assumed Value

1.0E-06 CF = 0.000001 kg/mg - Conversion Factor, (EPA, 1989a)

2.0E+02 IR = 200 mg/day - Ingestion Rate of soil by an adult worker, (OSWER, 1991)

1.0E+00 ED = 1 yr - Exposure Duration for an adult worker, (OSWER, 1991)

2.5E+02 EF = 250 days/yr - Exposure Frequency for an adult worker (5 days/wk for 50 wks) #

7.0E+01 BW = 70 kg - Body Weight for adult worker, (OSWER, 1991)

1.0E+00 ATN = 1 yr - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)

7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)

HIF--NON-CARCINOGENIC-------> 2.0E-06 HIF = ((CF * IR * ED * EF / BW)) / (ATN)(365)

HIF--CARCINOGENIC-------> 2.8E-08 HIF = ((CF * IR * ED * EF / BW)) / (ATC)(365)

DAILY INTAKE = (CS * HIF)

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-10
Dermal Contact with Onsite Subsurface Soil (0-10')
Onsite Adult
(Future Construction Worker Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Absorption Factor (ABS) unitless	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal RfD mg/kg-day	Hazard Quotent (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal Slope Factor kg-day/mg	Risk unitless
4,4'-DDD	1.7E+01	1.0E-02	2.0E-05	3.3E-06			2.5E-07	4.8E-08	4.8E-01	2.3E-08
4,4'-DDE	2.1E+00	1.0E-02	2.0E-05	4.1E-07			2.5E-07	5.9E-09	6.8E-01	4.0E-09
4,4'-DDT	2.7E+00	1.0E-02	2.0E-05	5.3E-07	2.5E-05	2.2E-03	2.5E-07	7.6E-09	6.8E-01	5.2E-09
Aldrin	1.5E+00	1.0E-02	2.0E-05	2.9E-07	1.5E-05	2.0E-02	2.5E-07	4.2E-09	3.4E+01	1.4E-07
Alpha-BHC	1.4E+00	1.0E-02	2.0E-05	2.7E-07			2.5E-07	3.9E-09	1.3E+01	4.9E-08
Beta-BHC	1.2E+00	1.0E-02	2.0E-05	2.3E-07			2.5E-07	3.4E-09	3.6E+00	1.2E-08
Chlordane	4.6E+01	1.0E-02	2.0E-05	9.0E-06	3.0E-05	3.0E-01	2.5E-07	1.3E-07	2.6E+00	3.3E-07
Dieldrin	2.0E+00	1.0E-02	2.0E-05	3.9E-07	2.5E-05	1.6E-02	2.5E-07	5.6E-09	3.2E+01	1.8E-07
Lindane (Gamma-BHC)	1.4E+00	1.0E-02	2.0E-05	2.7E-07	1.5E-04	1.8E-03	2.5E-07	3.9E-09	2.6E+00	1.0E-08
Endrin	6.7E+00	1.0E-02	2.0E-05	1.3E-06	1.5E-04	8.7E-03	2.5E-07	1.9E-08		
			Total Pathway Hazard Index------->			3E-01		Total Pathway Risk----->		8E-07

DERMAL CONTACT WITH SOIL
CS = Concentration of chemical in soil (mg/kg)
ABS = Absorption Factor - Assumed to be 0.01 for organics and 0.001 for inorganics

- Assumed Value

1.0E-06 CF = 0.000001 kg/mg - Conversion Facor, (EPA, 1989a)
2.0E+03 SA = 2000 sq cm - Skin Surface Area Available for Contact, hands and forearms, (EPA, 1989d)
2.5E+02 EF = 250 days/yr - Exposure Frequency for an adult worker (5 days/wk for 50 wks) #
1.0E+00 ED = 1 yr - Exposure Duration for adult worker, (OSWER, 1991)
7.0E+01 BW = 70 kg - Body Weight for adult worker, (OSWER, 1991)
1.0E+00 ATN = 1 yr - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)
7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)
1.0E+00 AF = 1.00 mg/sq cm - Adherence Factor, (EPA, Region X)

HIF-NON-CARCINOGENIC-------> 2.0E-05 HIF = (CF * SA * EF * ED * AF / BW)) / (ATN)(365)]
HIF-CARCINOGENIC-------> 2.5E-07 HIF = (CF * SA * EF * ED * AF / BW)) / (ATC)(365)]

DAILY INTAKE = (CS * ABS * HIF)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-11
Incidental Ingestion of Onsite Surface Soil (0 - 1')
Onsite Adult
(Future Residential Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral RfD mg/kg-day	Hazard Quotent (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral Slope Factor kg-day/mg	Risk unitless
4,4'-DDD	2.5E+00	1.4E-06	3.5E-06			4.7E-07	1.2E-06	2.4E-01	2.8E-07
4,4'-DDE	1.1E+00	1.4E-06	1.5E-06			4.7E-07	5.2E-07	3.4E-01	1.8E-07
4,4'-DDT	1.4E+00	1.4E-06	2.0E-06	5.0E-04	3.9E-03	4.7E-07	6.6E-07	3.4E-01	2.2E-07
Aldrin	1.2E+00	1.4E-06	1.7E-06	3.0E-05	5.6E-02	4.7E-07	5.6E-07	1.7E+01	9.6E-06
Beta-BHC	1.1E+00	1.4E-06	1.5E-06			4.7E-07	5.2E-07	1.8E+00	9.3E-07
Chlordane	8.6E+00	1.4E-06	1.2E-05	6.0E-05	2.0E-01	4.7E-07	4.0E-06	1.3E+00	5.3E-06
Dieldrin	1.2E+00	1.4E-06	1.6E-06	5.0E-05	3.3E-02	4.7E-07	5.6E-07	1.6E+01	9.0E-06
Heptachlor epoxide	6.0E-01	1.4E-06	8.4E-07	1.3E-05	6.5E-02	4.7E-07	2.8E-07	9.1E+00	2.6E-06
Total Pathway Hazard Index------->					4E-01	Total Pathway Risk---->			3E-05

INCIDENTAL INGESTION OF SOIL

CS = Concentration of chemical in soil (mg/kg)

1.0E-06 CF = 0.000001 kg/mg - Conversion Factor, (EPA, 1989a)

1.0E+02 IR = 100 mg/day - Ingestion Rate of soil by an adult, (EPA, 1992a)

2.4E+01 ED = 24 yrs - Exposure Duration for an adult, (EPA, 1992a)

3.5E+02 EF = 350 days/yr - Exposure Frequency for an adult, (EPA, 1992a)

7.0E+01 BW = 70 kg - Body Weight for an adult, (EPA, 1992a)

2.4E+01 ATN = 24 yrs - Averaging Time for non-carcinogenic compounds, EPA, 1992a)

7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)

HIF--NON-CARCINOGENIC-------> 1.4E-06 HIF = (IR * EF * ED / BW)*CF / (ATN)(365)

HIF--CARCINOGENIC-------> 4.7E-07 HIF = (IR * EF * ED / BW)*CF / (ATC)(365)

DAILY INTAKE = (CS * HIF)

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-12
Dermal Contact with Onsite Surface Soil (0 - 1')
Onsite Adult
(Future Residential Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Absorption Factor (ABS) unitless	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal RfD mg/kg-day	Hazard Quotent (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal Slope Factor kg-day/mg	Risk unitless
4,4'-DDD	2.5E+00	1.0E-02	7.3E-05	1.8E-06			2.5E-05	6.2E-07	4.8E-01	3.0E-07
4,4'-DDE	1.1E+00	1.0E-02	7.3E-05	8.0E-07			2.5E-05	2.7E-07	6.8E-01	1.9E-07
4,4'-DDT	1.4E+00	1.0E-02	7.3E-05	1.0E-06	2.5E-04	4.1E-03	2.5E-05	3.5E-07	6.8E-01	2.4E-07
Aldrin	1.2E+00	1.0E-02	7.3E-05	8.7E-07	1.5E-05	5.8E-02	2.5E-05	3.0E-07	3.4E+01	1.0E-05
Beta-BHC	1.1E+00	1.0E-02	7.3E-05	8.0E-07			2.5E-05	2.7E-07	3.6E+00	9.9E-07
Chlordane	8.6E+00	1.0E-02	7.3E-05	6.2E-06	3.0E-05	2.1E-01	2.5E-05	2.1E-06	2.6E+00	5.6E-06
Dieldrin	1.2E+00	1.0E-02	7.3E-05	8.7E-07	2.5E-05	3.5E-02	2.5E-05	3.0E-07	3.2E+01	9.6E-06
Heptachlor epoxide	6.0E-01	1.0E-02	7.3E-05	4.4E-07	1.3E-05	3.4E-02	2.5E-05	1.5E-07	9.1E+00	1.4E-06
NA - Data Not Available			Total Pathway Hazard Index-------->			3E-01	Total Pathway Risk----->			3E-05

DERMAL CONTACT WITH SOIL
CS = Concentration of chemical in soil (mg/kg)
ABS = Absorption Factor - Assumed to be 0.01 for organics and 0.001 for inorganics

1.0E-06 CF = 0.000001 kg/mg - Conversion Factor, (EPA, 1989a)
5.3E+03 SA = 5300 sq cm - Skin Surface Area, (Adult), hands, arms, and lower legs (OSWER, 1991)
3.5E+02 EF = 350 days/yr - Exposure Frequency, (Adult), (EPA, 1992a)
2.4E+01 ED = 24 yrs - Exposure Duration for adult, (EPA, 1992a)
7.0E+01 BW = 70 kg - Body Weight for adult, (7-16 yrs.), (EPA, 1992a)
2.4E+01 ATN = 24 yrs - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)
7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)
1.0E+00 AF = 1.00 mg/sq cm - Adherence Factor, (EPA, Region X)

HIF--NON-CARCINOGENIC----------> 7.3E-05 HIF = [(SA * EF * ED * AF / BW) * CF / (ATN)(365)]
HIF--CARCINOGENIC----------> 2.5E-05 HIF = [(SA * EF * ED * AF / BW) * CF / (ATC)(365)]

DAILY INTAKE = (CS * ABS * HIF)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-13
Incidental Ingestion of Onsite Surface Soil (0 - 1')
Onsite Child (age 1 - 6)
(Future Residential Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral RfD mg/kg-day	Hazard Quotent (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Oral Slope Factor kg-day/mg	Risk unitless
4,4'-DDD	2.5E+00	1.3E-05	3.2E-05			1.1E-06	2.7E-06	2.4E-01	6.6E-07
4,4'-DDE	1.1E+00	1.3E-05	1.4E-05			1.1E-06	1.2E-06	3.4E-01	4.1E-07
4,4'-DDT	1.4E+00	1.3E-05	1.8E-05	5.0E-04	3.6E-02	1.1E-06	1.5E-06	3.4E-01	5.2E-07
Aldrin	1.2E+00	1.3E-05	1.5E-05	3.0E-05	5.1E-01	1.1E-06	1.3E-06	1.7E+01	2.2E-05
Beta-BHC	1.1E+00	1.3E-05	1.4E-05			1.1E-06	1.2E-06	1.8E+00	2.2E-06
Chlordane	8.6E+00	1.3E-05	1.1E-04	6.0E-05	1.9E+00	1.1E-06	9.4E-06	1.3E+00	1.2E-05
Dieldrin	1.2E+00	1.3E-05	1.6E-05	5.0E-05	3.2E-01	1.1E-06	1.3E-06	1.6E+01	2.1E-05
Heptachlor epoxide	6.0E-01	1.3E-05	7.8E-06	1.3E-05	6.0E-01	1.1E-06	6.6E-07	9.1E+00	6.0E-06
		Total Pathway Hazard Index------->			3E+00	Total Pathway Risk---->			6E-05

INCIDENTAL INGESTION OF SOIL

CS = Concentration of chemical in soil (mg/kg)

1.0E-06 CF = 0.000001 kg/mg - Conversion Factor, (EPA, 1989a)

2.0E+02 IR = 200 mg/day - Ingestion Rate of soil by a child (0-6 yrs.), (EPA, 1992a)

6.0E+00 ED = 6 yrs - Exposure Duration for a child (1-6 yrs), (EPA, 1992a)

3.5E+02 EF = 350 days/yr - Exposure Frequency for a child (1-6 yrs), (EPA, 1992a)

1.5E+01 BW = 15 kg - Body Weight for a child (1-6 yrs), (EPA, 1992a)

6.0E+00 ATN = 6 yrs - Averaging Time for non-carcinogenic compounds, EPA, 1992a)

7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)

HIF--NON-CARCINOGENIC-------->

HIF--CARCINOGENIC-------->

1.3E-05 HIF = (IR * EF * ED / BW)*CF / (ATN)(365)

1.1E-06 HIF = (IR * EF * ED / BW)*CF / (ATC)(365)

DAILY INTAKE = (CS * HIF)

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-14
Dermal Contact with Onsite Surface Soil (0 - 1')
Onsite Child (age 1 - 6)
(Future Residential Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CS) mg/kg	Absorption Factor (ABS) unitless	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal RfD mg/kg-day	Hazard Quotent (HQ) unitless	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) kg/kg-day	Daily Intake mg/kg-day	Adjusted Dermal Slope Factor kg-day/mg	Risk unitless
4,4'-DDD	2.5E+00	1.0E-02	2.0E-04	5.1E-06			1.7E-05	4.3E-07	4.8E-01	2.1E-07
4,4'-DDE	1.1E+00	1.0E-02	2.0E-04	2.2E-06			1.7E-05	1.9E-07	6.8E-01	1.3E-07
4,4'-DDT	1.4E+00	1.0E-02	2.0E-04	2.8E-06	2.5E-04	1.1E-02	1.7E-05	2.4E-07	6.8E-01	1.6E-07
Aldrin	1.2E+00	1.0E-02	2.0E-04	2.4E-06	1.5E-05	1.6E-01	1.7E-05	2.1E-07	3.4E+01	7.1E-06
Beta-BHC	1.1E+00	1.0E-02	2.0E-04	2.2E-06			1.7E-05	1.9E-07	3.6E+00	6.9E-07
Chlordane	8.6E+00	1.0E-02	2.0E-04	1.7E-05	3.0E-05	5.8E-01	1.7E-05	1.5E-06	2.6E+00	3.9E-06
Dieldrin	1.2E+00	1.0E-02	2.0E-04	2.4E-06	2.5E-05	9.7E-02	1.7E-05	2.1E-07	3.2E+01	6.6E-06
Heptachlor epoxide	6.0E-01	1.0E-02	2.0E-04	1.2E-06	1.3E-05	9.3E-02	1.7E-05	1.0E-07	9.1E+00	9.5E-07
NA - Data Not Available			Total Pathway Hazard Index-------->			8E-01	Total Pathway Risk---->			2E-05

DERMAL CONTACT WITH SOIL
CS = Concentration of chemical in soil (mg/kg)
ABS = Absorption Factor - Assumed to be 0.01 for organics and 0.001 for inorganics

1.0E-06 CF = 0.000001 kg/mg - Conversion Factor, (EPA, 1989a)
3.2E+03 SA = 3160 sq cm - Skin Surface Area, (Child), hands, arms, and legs (OSWER, 1991)
3.5E+02 EF = 350 days/yr - *Exposure Frequency, (Child: 1-6 yrs.)*, (EPA, 1992a)
6.0E+00 ED = 6 yrs - Exposure Duration for child (1-6 yrs.), (EPA, 1992a)
1.5E+01 BW = 15 kg - Body Weight for child, (1-6 yrs.), (EPA, 1992a)
6.0E+00 ATN = 6 yrs - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)
7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)
1.0E+00 AF = 1.00 mg/sq cm - Adherence Factor, (EPA, Region X)

HIF--NON-CARCINOGENIC----------> 2.0E-04 HIF = [(SA * EF * ED * AF / BW) * CF / (ATN)(365)]
HIF--CARCINOGENIC----------> 1.7E-05 HIF = [(SA * EF * ED * AF / BW) * CF / (ATC)(365)]

DAILY INTAKE = (CS * ABS * HIF)
RISK (non-carcinogenic) = (INTAKE / RfD)
RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-15
Ingestion of Groundwater
Onsite Adult
(Future Residential Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CW) (mg/L)	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) (L/kg-day)	Daily Intake (mg/kg-day)	Oral RfD (mg/kg-day)	Hazard Quotent (HQ) (unitless)	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) (L/kg-day)	Daily Intake (mg/kg-day)	Oral Slope Factor (kg-day/mg)	Risk (unitless)
Benzene	4.2E-03	2.7E-02	1.2E-04			9.4E-03	3.9E-05	2.9E-02	1.1E-06
Chlorobenzene	9.9E-03	2.7E-02	2.7E-04	2.0E-02	1.3E-02	9.4E-03	9.3E-05		
Ethylbenzene	2.0E+00	2.7E-02	5.4E-02	1.0E-01	5.4E-01	9.4E-03	1.9E-02		
Xylene (mixed)	5.9E+00	2.7E-02	1.6E-01	2.0E+00	8.1E-02	9.4E-03	5.5E-02		
1,4-Dichlorobenzene	2.4E-02	2.7E-02	6.5E-04			9.4E-03	2.3E-04	2.4E-02	5.4E-06
4,4'-DDD	3.0E-03	2.7E-02	8.1E-05			9.4E-03	2.8E-05	2.4E-01	6.8E-06
Alpha-BHC	9.2E-03	2.7E-02	2.5E-04			9.4E-03	8.6E-05	6.3E+00	5.4E-04
Arochlor-1260	2.1E-03	2.7E-02	5.8E-05			9.4E-03	2.0E-05	7.7E+00	1.5E-04
Beta-BHC	7.0E-02	2.7E-02	1.9E-03			9.4E-03	6.6E-04	1.8E+00	1.2E-03
Delta-BHC	3.7E-02	2.7E-02	1.0E-03			9.4E-03	3.5E-04		
Lindane (Gamma-BHC)	3.6E-03	2.7E-02	9.7E-05	3.0E-04	3.2E-01	9.4E-03	3.4E-05	1.3E+00	4.4E-05
2-Methylnaphthalene	1.1E-01	2.7E-02	3.0E-03			9.4E-03	1.0E-03		
2,4-Dimethylphenol	2.8E-02	2.7E-02	7.6E-04	2.0E-02	3.8E-02	9.4E-03	2.6E-04		
Naphthalene	1.1E-01	2.7E-02	3.0E-03	4.0E-02	7.4E-02	9.4E-03	1.0E-03		
Arsenic	4.6E-02	2.7E-02	1.2E-03	3.0E-04	4.1E+00	9.4E-03	4.3E-04	1.8E+00	7.6E-04
Lead	1.2E-01	2.7E-02	3.3E-03			9.4E-03	1.1E-03		
		Total Pathway Hazard Index-------->			5E+00	Total Pathway Risk---->			3E-03

INGESTION OF GROUNDWATER

CW = Concentration of chemical in water (mg/L)

2.0E+00 IRA = 2 L/day - Ingestion Rate of water by an adult (7-30 yrs.), (OSWER, 1991)

2.4E+01 EDA = 24 yrs - Exposure Duration for an adult (7-30 yrs), (OSWER, 1991)

3.5E+02 EFA = 350 days/yr - Exposure Frequency for an adult (7-30 yrs), (OSWER, 1991)

7.0E+01 BWA = 70 kg - Body Weight for adult, (OSWER, 1991)

2.4E+01 ATN = 24 yrs - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)

7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)

HIF--NON-CARCINOGENIC---------> 2.7E-02 HIF = (IRA * EFA * EDA / BWA) / (ATN)(365)

HIF--CARCINOGENIC----------> 9.4E-03 HIF = (IRA * EFA * EDA / BWA) / (ATC)(365)

DAILY INTAKE = (CW * HIF)

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-16
Inhalation of Groundwater (Volatilized Contaminants)
Onsite Adult
(Future Residential Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CW) (mg/L)	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) (L/kg-day)	Chronic Non-Carcinogenic Effects: Daily Intake (mg/kg-day)	Chronic Non-Carcinogenic Effects: Inhalation RfD (mg/kg-day)	Chronic Non-Carcinogenic Effects: Hazard Quotient (HQ) (unitless)	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) (L/kg-day)	Lifetime Carcinogenic Effects: Daily Intake (mg/kg-day)	Lifetime Carcinogenic Effects: Inhalation Slope Factor (kg-day/mg)	Lifetime Carcinogenic Effects: Inhalation Risk (unitless)
Benzene	4.2E-03	2.7E-02	1.1E-04	1.7E-03	6.4E-02	9.4E-03	3.9E-05	2.9E-02	1.1E-06
Chlorobenzene	9.9E-03	2.7E-02	2.7E-04	5.7E-03	4.7E-02	9.4E-03	9.3E-05		
Ethylbenzene	2.0E+00	2.7E-02	5.5E-02	2.9E-01	1.9E-01	9.4E-03	1.9E-02		
Xylene (mixed)	5.9E+00	2.7E-02	1.6E-01	2.0E+00	8.1E-02	9.4E-03	5.5E-02		
1,4-Dichlorobenzene	2.4E-02	2.7E-02	6.5E-04	2.3E-01	6.6E-04	9.4E-03	2.3E-04	2.4E-02	5.4E-06
4,4'-DDD	3.0E-03	2.7E-02	8.1E-05			9.4E-03	2.8E-05		
Alpha-BHC	9.2E-03	2.7E-02	2.5E-04			9.4E-03	8.6E-05		
Arochlor-1260	2.1E-03	2.7E-02	5.8E-05			9.4E-03	2.0E-05		
Beta-BHC	7.0E-02	2.7E-02	1.9E-03			9.4E-03	6.6E-04		
Delta-BHC	3.7E-02	2.7E-02	1.0E-03			9.4E-03	3.5E-04		
Lindane (Gamma-BHC)	3.6E-03	2.7E-02	9.7E-05			9.4E-03	3.4E-05		
2-Methylnaphthalene	1.1E-01	2.7E-02	3.0E-03			9.4E-03	1.0E-03		
2,4-Dimethylphenol	2.8E-02	2.7E-02	7.6E-04			9.4E-03	2.6E-04		
Naphthalene	1.1E-01	2.7E-02	3.0E-03			9.4E-03	1.0E-03		
Arsenic	4.6E-02	2.7E-02	1.2E-03			9.4E-03	4.3E-04		
Lead	1.2E-01	2.7E-02	3.3E-03			9.4E-03	1.1E-03		
		Total pathway Hazard Index------->			4E-01		Total pathway Risk---->		7E-06

- Assumed Values

INHALATION DUE TO SHOWERING

CW = Concentration of Chemical in water (mg/L)

2.0E+00 IRA = 2 L/day - Ingestion Rate of water by an adult (7-30 yrs.), (OSWER, 1991)

3.5E+02 EFA = 350 days/ year - Exposure Frequency, (OSWER, 1991)

2.4E+01 EDA = 24 years - Exposure duration for adult (7-30 yrs), (OSWER, 1991)

7.0E+01 BWA = 70 kg - Body Weight for adult, (OSWER, 1991)

2.4E+01 ATN = 24 years - Averaging Time for non-carcinogenic compounds (OSWER,1991)

7.0E+01 ATC = 70 years - Averaging Time for carcinogenic compounds, (OSWER, 1991)

2.7E-02 HIF = (IRA * EFA * EDA / BWA) / (ATN)(365)

HIF--NON-CARCINOGENIC---------> 9.4E-03 HIF = (IRA * EFA * EDA / BWA) / (ATC)(365)

HIF--CARCINOGENIC----------> DAILY INTAKE = (CW * HIF) - Assumes ingestion of 2 L/day groundwater

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-17
Ingestion of Groundwater
Onsite Child (age 1 - 6)
(Future Residential Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CW) (mg/L)	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) (L/kg-day)	Daily Intake (mg/kg-day)	Oral RfD (mg/kg-day)	Hazard Quotent (HQ) (unitless)	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) (L/kg-day)	Daily Intake (mg/kg-day)	Oral Slope Factor (kg-day/mg)	Risk (unitless)
Benzene	4.2E-03	6.4E-02	2.7E-04			5.5E-03	2.3E-05	2.9E-02	6.7E-07
Chlorobenzene	9.9E-03	6.4E-02	6.3E-04	2.0E-02	3.2E-02	5.5E-03	5.4E-05		
Ethylbenzene	2.0E+00	6.4E-02	1.3E-01	1.0E-01	1.3E+00	5.5E-03	1.1E-02		
Xylene (mixed)	5.9E+00	6.4E-02	3.8E-01	2.0E+00	1.9E-01	5.5E-03	3.2E-02		
1,4-Dichlorobenzene	2.4E-02	6.4E-02	1.5E-03			5.5E-03	1.3E-04	2.4E-02	3.2E-06
4,4'-DDD	3.0E-03	6.4E-02	1.9E-04			5.5E-03	1.6E-05	2.4E-01	3.9E-06
Alpha-BHC	9.2E-03	6.4E-02	5.9E-04			5.5E-03	5.0E-05	6.3E+00	3.2E-04
Arochlor-1260	2.1E-03	6.4E-02	1.3E-04			5.5E-03	1.2E-05	7.7E+00	8.9E-05
Beta-BHC	7.0E-02	6.4E-02	4.5E-03			5.5E-03	3.8E-04	1.8E+00	6.9E-04
Delta-BHC	3.7E-02	6.4E-02	2.4E-03			5.5E-03	2.0E-04		
Lindane (Gamma-BHC)	3.6E-03	6.4E-02	2.3E-04	3.0E-04	7.7E-01	5.5E-03	2.0E-05	1.3E+00	2.6E-05
2-Methylnaphthalene	1.1E-01	6.4E-02	7.0E-03			5.5E-03	6.0E-04		
2,4-Dimethylphenol	2.8E-02	6.4E-02	1.8E-03	2.0E-02	9.0E-02	5.5E-03	1.5E-04		
Naphthalene	1.1E-01	6.4E-02	7.0E-03	4.0E-02	1.8E-01	5.5E-03	6.0E-04		
Arsenic	4.6E-02	6.4E-02	2.9E-03	3.0E-04	9.8E+00	5.5E-03	2.5E-04	1.8E+00	4.4E-04
Lead	1.2E-01	6.4E-02	7.7E-03			5.5E-03	6.6E-04		
		Total Pathway Hazard Index-------->			1E+01	Total Pathway Risk----->			2E-03

INGESTION OF GROUNDWATER

CW = Concentration of chemical in water (mg/L)

1.0E+00 IRC = 1 L/day - Ingestion Rate of water by a child (0-6 yrs.), (OSWER, 1991)

6.0E+00 EDC = 6 yrs - Exposure Duration for a child (1-6 yrs), (OSWER, 1991)

3.5E+02 EFC = 350 days/yr - Exposure Frequency for a child (1-6 yrs), (OSWER, 1991)

1.5E+01 BWC = 15 kg - Body Weight for a child (1-6 yrs), (OSWER, 1991)

6.0E+00 ATN = 6 yrs - Averaging Time for non-carcinogenic compounds, (OSWER, 1991)

7.0E+01 ATC = 70 yrs - Averaging Time for carcinogenic compounds, (OSWER, 1991)

HIF-NON-CARCINOGENIC----------> 6.4E-02 HIF = (IRC * EFC * EDC / BWC / (ATN)(365)

HIF--CARCINOGENIC----------> 5.5E-03 HIF = (IRC * EFC * EDC / BWC / (ATC)(365)

DAILY INTAKE = (CW * HIF)

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-18
Inhalation of Groundwater (Volatilized Contaminants)
Onsite Child (age 1 - 6)
(Future Residential Scenario)

Chevron Orlando Site
Risk Assessment

Contaminants or Chemicals	RME Conc (CW) (mg/L)	Chronic Non-Carcinogenic Effects: Human Intake Factor (HIF) (L/kg-day)	Daily Intake (mg/kg-day)	Inhalation RfD (mg/kg-day)	Hazard Quotient (HQ) (unitless)	Lifetime Carcinogenic Effects: Human Intake Factor (HIF) (L/kg-day)	Daily Intake (mg/kg-day)	Inhalation Slope Factor (kg-day/mg)	Inhalation Risk (unitless)
Benzene	4.2E-03	6.4E-02	2.7E-04	1.7E-03	1.6E-01	5.5E-03	2.3E-05	2.9E-02	6.7E-07
Chlorobenzene	9.9E-03	6.4E-02	6.3E-04	5.7E-03	1.1E-01	5.5E-03	5.4E-05		
Ethylbenzene	2.0E+00	6.4E-02	1.3E-01	2.9E-01	4.5E-01	5.5E-03	1.1E-02		
Xylene (mixed)	5.9E+00	6.4E-02	3.8E-01	2.0E+00	1.9E-01	5.5E-03	3.2E-02		
1,4-Dichlorobenzene	2.4E-02	6.4E-02	1.5E-03	2.3E-01	6.7E-03	5.5E-03	1.3E-04	2.4E-02	3.2E-06
4,4'-DDD	3.0E-03	6.4E-02	1.9E-04			5.5E-03	1.6E-05		
Alpha-BHC	9.2E-03	6.4E-02	5.9E-04			5.5E-03	5.0E-05		
Arochlor-1260	2.1E-03	6.4E-02	1.3E-04			5.5E-03	1.2E-05		
Beta-BHC	7.0E-02	6.4E-02	4.5E-03			5.5E-03	3.8E-04		
Delta-BHC	3.7E-02	6.4E-02	2.4E-03			5.5E-03	2.0E-04		
Lindane (Gamma-BHC)	3.6E-03	6.4E-02	2.3E-04			5.5E-03	2.0E-05		
2-Methylnaphthalene	1.1E-01	6.4E-02	7.0E-03			5.5E-03	6.0E-04		
2,4-Dimethylphenol	2.8E-02	6.4E-02	1.8E-03			5.5E-03	1.5E-04		
Naphthalene	1.1E-01	6.4E-02	7.0E-03			5.5E-03	6.0E-04		
Arsenic	4.6E-02	6.4E-02	2.9E-03			5.5E-03	2.5E-04		
Lead	1.2E-01	6.4E-02	7.7E-03			5.5E-03	6.6E-04		
		Total pathway Hazard Index------->			9E-01		Total pathway Risk---->		4E-06

- Assumed Values

INHALATION DUE TO SHOWERING

CW = Concentration of Chemical in water (mg/L)

1.0E+00 IRC = 1 L/day - Ingestion Rate of water by a child (1-6 yrs.), (OSWER, 1991)

3.5E+02 EFC = 350 days/ year - Exposure Frequency, (OSWER, 1991)

6.0E+00 EDC = 6 years - Exposure duration for child (1-6 yrs), (OSWER, 1991)

1.5E+01 BWC = 15 kg - Body Weight for child, (OSWER, 1991)

6.0E+00 ATN = 6 years - Averaging Time for non-carcinogenic compounds (OSWER,1991)

7.0E+01 ATC = 70 years - Averaging Time for carcinogenic compounds, (OSWER, 1991)

6.4E-02 HIF = (IRA * EFA * EDA / BWA) / (ATN)(365)

HIF--NON-CARCINOGENIC---------> 5.5E-03 HIF = (IRA * EFA * EDA / BWA) / (ATC)(365)

HIF--CARCINOGENIC----------->

DAILY INTAKE = (CW * HIF) - Assumes ingestion of 1 L/day groundwater

RISK (non-carcinogenic) = (INTAKE / RfD)

RISK (carcinogenic) = (INTAKE * SLOPE FACTOR)

Table 5-19
Summary of Carcinogenic Risks
Chevron Orlando Site
Risk Assessment

POPULATION	EXPOSURE PATHWAY	PATHWAY RISK
Offsite Child Resident (age 1 - 6) (Current Use)	Incidental ingestion (offsite surface soil, 0'-1')	7E-06
	Dermal contact (offsite surface soil, 0'-1')	2E-06
	Total Risk	**9E-06**
Offsite Adult Resident (age 7 - 30) (Current Use)	Incidental ingestion (offsite surface soil, 0'-1')	3E-06
	Dermal contact (offsite surface soil, 0'-1')	3E-06
	Total Risk	**6E-06**
Offsite Resident (age 1 - 30) (Current Use)	**Total Lifetime Risk (Child + Adult)**	**2E-05**
Onsite Adolescent Trespasser (Current Use)	Incidental ingestion (onsite surface soil, 0'-1')	5E-06
	Dermal contact (onsite surface soil, 0'-1')	5E-06
	Total Risk	**1E-05**
Onsite Child Resident (age 1 - 6) (Future Use)	Ingestion (groundwater)	2E-03
	Inhalation, from showering (groundwater)	4E-06
	Incidental ingestion (onsite surface soil, 0'-1')	6E-05
	Dermal contact (onsite surface soil, 0'-1')	2E-05
	Total Risk	**2E-03**
Onsite Adult Resident (age 7 - 30) (Future Use)	Ingestion (groundwater)	3E-03
	Inhalation, from showering (groundwater)	7E-06
	Incidental ingestion (onsite surface soil, 0'-1')	3E-05
	Dermal contact (onsite surface soil, 0'-1')	3E-05
	Total Risk	**3E-03**
Onsite Resident (age 1 - 30) (Future Use)	**Total Lifetime Risk (Child + Adult)**	**5E-03**
Onsite Adult Worker (Future Use)	Incidental ingestion (onsite surface soil, 0'-1')	9E-06
	Dermal contact (onsite surface soil, 0'-1')	8E-06
	Total Risk	**2E-05**
Onsite Adult Construction Worker (Future Use)	Incidental ingestion (onsite soil, 0'-10')	4E-06
	Dermal contact (onsite soil, 0'-10')	8E-07
	Total Risk	**5E-06**
Offsite Child Resident (age 1 - 6) (Future Use)	Incidental ingestion (offsite surface soil, 0'-1')	7E-06
	Dermal contact (offsite surface soil, 0'-1')	2E-06
	Total Risk	**9E-06**
Offsite Adult Resident (age 7 - 30) (Future Use)	Incidental ingestion (offsite surface soil, 0'-1')	3E-06
	Dermal contact (offsite surface soil, 0'-1')	3E-06
	Total Risk	**6E-06**
Offsite Resident (age 1 - 30) (Future Use)	**Total Lifetime Risk (Child + Adult)**	**2E-05**
Onsite Adolescent Trespasser (Future Use)	Incidental ingestion (onsite surface soil, 0'-1')	5E-06
	Dermal contact (onsite surface soil, 0'-1')	5E-06
	Total Risk	**1E-05**

Table 5-20
Summary of Non-Carcinogenic Risks
Chevron Orlando Site
Risk Assessment

POPULATION	EXPOSURE PATHWAY	PATHWAY HAZARD INDEX
Offsite Child Resident (Current Use)	Incidental ingestion (offsite surface soil, 0'-1')	8E-01
	Dermal contact (offsite surface soil, 0'-1')	3E-01
	Total Hazard Index	**1E+00**
Offsite Adult Resident (Current Use)	Incidental ingestion (offsite surface soil, 0'-1')	9E-02
	Dermal contact (offsite surface soil, 0'-1')	1E-01
	Total Hazard Index	**2E-01**
Onsite Adolescent Trespasser (Current Use)	Incidental ingestion (onsite surface soil, 0'-1')	2E-01
	Dermal contact (onsite surface soil, 0'-1')	1E-01
	Total Hazard Index	**3E-01**
Onsite Child Resident (Future Use)	Ingestion (groundwater)	1E+01
	Inhalation, from showering (groundwater)	9E-01
	Incidental ingestion (onsite surface soil, 0'-1')	3E+00
	Dermal contact (onsite surface soil, 0'-1')	8E-01
	Total Hazard Index	**1E+01**
Onsite Adult Resident (Future Use)	Ingestion (groundwater)	5E+00
	Inhalation, from showering (groundwater)	4E-01
	Incidental ingestion (onsite surface soil, 0'-1')	4E-01
	Dermal contact (onsite surface soil, 0'-1')	3E-01
	Total Hazard Index	**6E+00**
Onsite Adult Worker (Future Use)	Incidental ingestion (onsite surface soil, 0'-1')	1E-01
	Dermal contact (onsite surface soil, 0'-1')	8E-02
	Total Hazard Index	**2E-01**
Onsite Adult Construction Worker (Future Use)	Incidental ingestion (onsite soil, 0'-10')	2E+00
	Dermal contact (onsite soil, 0'-10')	3E-01
	Total Hazard Index	**2E+00**
Offsite Child Resident (Future Use)	Incidental ingestion (offsite surface soil, 0'-1')	8E-01
	Dermal contact (offsite surface soil, 0'-1')	3E-01
	Total Hazard Index	**1E+00**
Offsite Adult Resident (Future Use)	Incidental ingestion (offsite surface soil, 0'-1')	9E-02
	Dermal contact (offsite surface soil, 0'-1')	1E-01
	Total Hazard Index	**2E-01**
Onsite Adolescent Trespasser (Future Use)	Incidental ingestion (onsite surface soil, 0'-1')	2E-01
	Dermal contact (onsite surface soil, 0'-1')	1E-01
	Total Hazard Index	**3E-01**

5.2 Evaluation of Carcinogenic Risks

The incremental risk of developing cancer from exposure to a chemical at the site is defined as the additional probability that an individual exposed will develop cancer during his or her lifetime (assumed to be 70 years). This value is calculated from the average daily intake over a lifetime (CDI) and the slope factor (SF) for the chemical as follows (EPA, 1989a):

$$\text{Risk} = \text{CDI} \times \text{SF}$$

When the product of CDI x SF is greater than 0.01, this expression may be estimated as:

$$\text{Risk} = 1 - \exp^{(-\text{CDI} \times \text{SF})}$$

Using the first equation, where appropriate, and employing the CDI values calculated for lifetime exposure along with the SF values (Table 4-1), cancer risks were calculated for lifetime exposures which may occur at this site. A summary of the results is presented in the risk characterization tables (5-1 through 5-18). It is important to note that the carcinogenic risk estimates presented in Tables 5-1 through 5-18 represent the summation of the individual risks associated with each of the chemicals of potential concern for which cancer information is adequately available. The total cancer risks (the sum of the individual pathways for each population) are contained in Table 5-19.

According to EPA policy, the target total individual risk resulting from exposures at a superfund site may range anywhere between 1E-04 and 1E-06 (EPA, 1990c). Thus, remedial alternatives being considered should be capable of reducing total potential carcinogenic risks to individuals to levels within this range. OSWER Directive 9355.0-30, issued on April 22, 1991, provides further insight into the acceptable risk range when it states: "Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts. However, if MCLs or non-zero MCLGs are exceeded, action generally is warranted. A risk manager may also decide that a baseline risk level less than 10^{-4} is unacceptable due to site specific reasons and that a remedial action is warranted. The upper boundary of the risk

range is not a discrete line at 1 x 10^{-4}, although USEPA generally uses 1 x 10^{-4} in making risk management decisions. A specific risk estimate around 10^{-4} may be considered acceptable if justified based on site-specific conditions."

Some of the exposure scenarios evaluated have potential carcinogenic risks in excess of the accepted USEPA benchmark of 1E-06 to 1E-04. A summary of carcinogenic risks for each population is discussed below.

The total incremental cancer risk for the current/future adolescent trespasser is 1E-05. This risk is primarily due to incidental ingestion of, and dermal contact with, dieldrin, aldrin, and chlordane in onsite surface soil. The total lifetime incremental cancer risk for current/future offsite residents (child and adult) is 2E-05 due to incidental ingestion of, and dermal contact with, chlordane and dieldrin in offsite surface soil.

The total incremental cancer risks for future onsite workers and construction workers are 2E-05 and 5E-06, respectively. These risks are primarily due to incidental ingestion of, and dermal contact with, chlordane, dieldrin, and aldrin in onsite soil (Tables 5-7 through 5-10).

Finally, the total incremental lifetime cancer risk for future onsite residents (child and adult) is 5E-03. This risk is primarily due to ingestion of beta-BHC, arsenic, and alpha-BHC in groundwater. Also, exposure to pesticides in onsite surface soil contributed a risk of 1E-04 (Table 5-19).

5.3 Evaluation of Noncarcinogenic Risks

The risk of adverse noncarcinogenic effects from chemical exposure is expressed in terms of the hazard quotient (HQ). The HQ is the ratio of the estimated dose (DI) which a human receives to the RfD, the estimated dose below which it is unlikely for even sensitive populations to experience adverse health effects. The HQ is calculated as follows (EPA, 1989a):

$$\mathbf{HQ = DI/RfD}$$

Where:

HQ = Hazard Quotient (unitless)

DI = Daily Intake (mg/kg/day)
Rfd = Reference Dose (mg/kg/day)

All the HQ values for chemicals within each exposure pathway are summed to yield the hazard index (HI). If the value of HI is less than 1.0, it is interpreted to mean that the risk of noncarcinogenic injury is low. If the HI is greater than 1.0, it is indicative of some degree of noncarcinogenic risk, or effect. Using the HQ equation, the chronic DI values, and the RfD values, a hazard index for each of the exposure scenarios considered in this risk assessment was calculated for each chemical of potential concern associated with that pathway and exposure point. Only chronic HIs are derived, as the subchronic risks will always be equal to or less than the chronic risks. The results of these calculations are summarized in Table 5-1 through 5-18.

An evaluation of the noncarcinogenic risk calculations presented in Table 5-20 indicates that many of the hazard indices under the current and future use scenarios are above 1.0. As stated above, a hazard index that exceeds 1.0 is indicative of some degree of noncarcinogenic risk.

None of the current/future scenarios - adolescent trespasser, offsite child resident, and offsite adult resident - has a total hazard index that is greater than 1.0. The total hazard index (HI) for the adolescent trespasser is 0.3. The total HIs for offsite child and adult residents are 1 and 0.2, respectively. As indicated above, when the HI value is equal to or less than 1, it is interpreted to mean that the risk of noncarcinogenic injury is low.

The total HI for future onsite workers exposed to onsite surface soil is 0.2. However, the total HI for future onsite construction workers exposed to onsite surface and subsurface soil is 2. This HI is primarily due to incidental ingestion of chlordane in onsite soil (Table 5-9).

The total HIs for future onsite child and adult residents are 10 and 6, respectively. These HIs are primarily due to ingestion of arsenic in groundwater. Also, ingestion of pesticides in onsite surface soil contributed significantly to the HI for future onsite child residents (Table 5-13).

5.4 Uncertainties in the Risk Characterization

The factors that contribute uncertainty to the estimates of exposure concentrations, daily intakes, and toxicity information also contribute uncertainty to the estimates of risk. These factors include:

- Chemicals not included.
- Exposure pathways not considered.
- Derivation of exposure point concentrations.
- Intake uncertainty.
- Toxicological dose-response and toxicity values.

If a compound did not have an assigned slope factor and it had data qualifiers indicating the presumptive evidence of its presence, it was eliminated from the quantitative risk assessment. If a compound was not detected above the quantitation limit, it was also eliminated from the risk assessment. In addition, compounds that do not have an assigned reference dose or slope factor (whether or not there were any data qualifiers) were eliminated from the risk assessment. Elimination of these compounds will result in an underestimation of risk.

There are uncertainties associated with summing cancer risks or hazard indices for different chemicals. The assumption of the additive properties of dosage ignores possible synergism or antagonism among chemicals and differences in mechanisms of action and metabolism. It is not known what effects this has on the total risk numbers.

Another important uncertainty surrounds the fact that risk calculations for dermal exposure to all compounds assume a relationship between the oral toxicity values and the extrapolated dermal value. Also, if a volatile organic compound did not have inhalation toxicity values, the oral RfD and/or SF were used to calculate risks associated with inhalation exposure while showering. These uncertainties and the uncertainties discussed in previous sections need to be considered when evaluating the results of the risk assessment and when making risk management decisions for the site.

6.0 Remedial Goal Options for Chevron (Orlando)

This section contains the site-specific Remedial Goal Options (RGOs) and the methodology used to calculate these goals for the Chevron site. RGOs were developed for all exposure pathways (i.e., ingestion of groundwater) that have a total carcinogenic risk exceeding 1E-04 or a total hazard index that exceeds 1.0. Individual chemicals contributing risks to these pathways had RGOs developed if their contribution was greater than or equal to 1E-06 for carcinogens or yielded a hazard quotient (HQ) greater than or equal to 0.1 for noncarcinogens. Using the above criteria, exposure pathways and receptors for which RGOs were calculated were selected from Tables 5-19 and 5-20. The appropriate chemicals were selected from Tables 5-1 through 5-18.

The exposure assumptions and models used in the baseline risk assessment were used to develop the site-specific RGOs. This leads to the risk level for a given chemical being directly proportional to the exposure concentration. The following equation was used to calculate the chemical-specific risk-based RGOs:

$$RG = \frac{TR \times EC}{CR}$$

Where:

RG = Risk-Based Remediation Goal

TR = Target Risk Level (HQ = 0.1, 1 and 10 for noncarcinogenic effects and risk level = 1E-6, 1E-5 and 1E-4 for carcinogenic effects).

EC = Exposure Concentrations in Groundwater and Soil (Tables 3-2 through 3-7).

CR = Calculated Risk Level (Tables 5-1 through 5-18).

Tables 6-1 through 6-6 present the media-specific RGOs for the contaminants of concern for each exposure scenario (refer to Tables 5-1 through 5-20 for the media, scenarios, and contaminants of concern which present unacceptable risks). The derived RGOs reflect the combined exposure through the applicable exposure routes

for any given medium (i.e., for exposure to surface soil, incidental ingestion and dermal contact were combined).

Table 6-1
Risk-Based Remedial Goal Options
Future Onsite Child Resident - Surface Soil (mg/kg)
CHEVRON ORLANDO SITE
Orlando, Florida

CHEMICAL	HAZARD INDEX			CARCINOGENIC RISK		
	0.1	1.0	10	10^{-6}	10^{-5}	10^{-4}
Heptachlor Epoxide	0.086	0.86	8.6	0.087	0.87	8.7
Beta-BHC	NA	NA	NA	0.38	3.8	38
Aldrin	0.18	1.8	18	0.041	0.41	4.1
Dieldrin	0.29	2.9	29	0.043	0.43	4.3
Chlordane	0.35	3.5	35	0.54	5.4	54

NOTES:

-- Not Detected.
Exposure routes: ingestion, dermal contact.

Table 6-2
Risk-Based Remedial Goal Options
Future Onsite Child Resident - Groundwater (mg/L)
CHEVRON ORLANDO SITE
Orlando, Florida

CHEMICAL	HAZARD INDEX			CARCINOGENIC RISK			FLORIDA PRIMARY STANDARDS	MAXIMUM CONTAMINANT LEVEL
	0.1	1.0	10	10^{-6}	10^{-5}	10^{-4}		
Ethylbenzene	0.11	1.1	11	NA	NA	NA	.7	0.7
Xylene (mixed)	1.5	15	150	NA	NA	NA	10	10
Lindane (Gamma-BHC)	0.00047	0.0047	0.047	0.00014	0.0014	0.014	.0002	0.0002
Arsenic	0.00046	0.0046	0.046	0.0001	0.0001	0.01	.05	0.05
Alpha-BHC	NA	NA	NA	0.00003	0.0003	0.003	NA	NA
Beta-BHC	NA	NA	NA	0.0001	0.001	0.01	NA	NA
Arochlor-1260	NA	NA	NA	0.00002	0.0002	0.002	.0005	NA
4,4-DDD	NA	NA	NA	0.0008	0.008	0.08	NA	NA
Naphthalene	0.06	0.6	6	NA	NA	NA	NA	NA
4-Dichlorobenzene	NA	NA	NA	0.004	0.04	0.4	NA	NA

NOTES:

-- Not Detected.
Exposure routes: ingestion and inhalation while showering.

NA Not Available

Table 6-3
Risk-Based Remedial Goal Options
Future Onsite Adult Resident - Groundwater (mg/L)
CHEVRON ORLANDO SITE
Orlando, Florida

CHEMICAL	HAZARD INDEX			CARCINOGENIC RISK			FLORIDA PRIMARY STANDARDS	MAXIMUM CONTAMINANT LEVEL
	0.1	1.0	10	10^{-6}	10^{-5}	10^{-4}		
Benzene	NA	NA	NA	0.002	0.02	0.2	0.001	0.005
Ethylbenzene	0.27	2.7	27	NA	NA	NA	0.7	0.7
1,4-Dichlorobenzene	NA	NA	NA	0.0022	0.022	0.22	0.075	NA
Lindane (Gamma-BHC)	NA	NA	NA	0.00008	0.0008	0.008	0.0002	0.0002
Arsenic	0.0011	0.011	0.11	0.00006	0.0006	0.006	0.05	0.05
Alpha-BHC	NA	NA	NA	0.00002	0.0002	0.002	NA	NA
Beta-BHC	NA	NA	NA	0.00006	0.0006	0.006	NA	NA
Arochlor-1260	NA	NA	NA	0.000014	0.0001	0.001	0.0005	NA
4,4-DDD	NA	NA	NA	0.0004	0.004	0.04	NA	NA

NOTES:

-- Not Detected.
Exposure Routes: ingestion and inhalation while showering.
NA Not Available

3 12 0100

Table 6-4
Risk-Based Remedial Goal Options
Future Onsite Adult Resident - Surface Soil (mg/kg)
CHEVRON ORLANDO SITE
Orlando, Florida

CHEMICAL	HAZARD INDEX			CARCINOGENIC RISK		
	0.1	1.0	10	10^{-6}	10^{-5}	10^{-4}
Aldrin	1.1	11	110	0.06	0.6	6
Heptachlor Epoxide	0.62	6.2	62	0.15	1.5	15
Chlordane	2.1	21	210	0.79	7.9	79
Dieldrin	1.8	18	180	0.065	0.65	6.5

NOTES:

-- Not Detected.
Exposure routes: ingestion, dermal contact.

Table 6-5
Risk-Based Remedial Goal Options
Future Onsite Construction Worker - Subsurface Soil (mg/kg)
CHEVRON ORLANDO SITE
Orlando, Florida

CHEMICAL	HAZARD INDEX			CARCINOGENIC RISK		
	0.1	1.0	10	10^{-6}	10^{-5}	10^{-4}
Aldrin	1.2	12	120	1.8	18	180
Chlordane	2.5	25	250	22	220	2200

NOTES:

-- Not Detected.
Exposure routes: ingestion, dermal contact.

7.0 Environmental Assessment

7.1 Problem Formulation

Media of concern for ecological receptors generally include surface water, sediments, surficial soils, shallow groundwater, and air. These are media that may all have direct or indirect effect on the community and population composition of an ecological habitat or on individual species that are part of those communities or populations.

The Chevron Chemical Company/Ortho Division site is relatively flat and does not appear to have any runoff of surface water. There may be some runoff in high rainfall events into a storm drain system on Orange Blossom Trail, however, it is uncertain where the system discharges to and there were no surface water or sediment samples taken as part of the remedial investigation. The only ecological media of concern evaluated at the site were on-site surficial soils, surficial soils in the trailer park north of the site, and shallow groundwater in the site area.

Ecological chemicals of potential concern may often include more individual contaminants than the human health assessment because the screening criteria for human health do not apply to ecological receptors. As a result, some different screening criteria are used to narrow the contaminants evaluated in the ecological assessment. The preliminary list of ecological chemicals of potential concern initially included all contaminants detected during previous environmental sampling events. This preliminary list was then refined as follows:

(1) All contaminants with a low frequency of detection (less than 5% for each medium) were eliminated from consideration.

(2) All inorganic constituents in surficial soils for which the range of detection did not exceed the chemical's natural background concentrations were eliminated from consideration. The natural background concentration was based on the data in USGS Professional Paper 1270, "Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States". No site-specific background samples were obtained in this investigation.

(3) All chemicals in groundwater for which the range of detection did not exceed the Region IV Freshwater Screening Criteria for freshwater environments were eliminated from consideration.

Tables 7-1 and 7-2 present the preliminary list of ecological chemicals of potential concern for surficial soils and shallow groundwater. After applying the elimination criteria to this list, the chemicals on the following table, Table 7-3 are the ecological chemicals of potential concern at the site.

7.1.1 Potentially Exposed Ecological Receptors

The Chevron Orlando site is a vacant lot that is surrounded by a 6-foot high, chain-link, barbed-wire fence. Much of the surface soil of this lot has been removed and backfilled with clean fill material. Grasses and weeds have revegetated most of this backfilled soil and covers approximately 75% of the soil surface. Wildlife including birds and insects was observed on the site. The Chevron Orlando site itself is a typical urban/industrial open field habitat.

The areas adjacent to the site include: a residential trailer park to the north, a light industrial and commercial area across Orange Blossom Trail to the east, a vacant lot and industrial areas across railroad tracks to the south, and an industrial area to the west. The ecological habitats near the site are shown in Figure 7-1 and include:

- An aquatic and shrub-scrub/emergent wetland complex (Lake Fairview) located approximately 700 feet to the northeast of the site.
- A flat pinewoods upland habitat located approximately 1,800 feet southwest of the site.
- A cypress swamp wetland habitat located approximately 2,700 feet southwest of the site.

There are three smaller lakes located further to the east that provide additional aquatic and shrub-scrub/emergent wetland complex habitat; however, these lakes are located east of Lake Fairview and would not be expected to be impacted by contaminated groundwater. Groundwater flow in the shallow aquifer is to the northeast toward Lake Fairview.

TABLE 7-1
CHEMICALS DETECTED IN SOIL SAMPLES (SURFACE)
CHEVRON ORLANDO SITE

Chemical	Frequency of Detection	Range of Detects (mg/kg)	Average Detected Concentration (1) (mg/kg)	REASON FOR ELIMINATION (If applicable)
PESTICIDE/PCBs				
4,4'-DDD	25 / 81	0.04 - 21	4.226	
4,4'-DDE	12 / 79	0.147 - 3.1	1.246	
4,4'-DDT	27 / 81	0.053 - 58	4.229	
ALDRIN	5 / 82	0.019 - 13	3.434	
ALPHA-BHC	4 / 82	1.1 - 130	34.475	Detected at less than 5% frequency
BETA-BHC	7 / 82	0.005 - 21	3.462	
CHLORDANE	54 / 82	0.088 - 79	8.96	
DELTA-BHC	3 / 81	0.012 - 3.3	1.90	Detected at less than 5% frequency
DIELDRIN	12 / 79	0.029 - 11	2.486	
ENDRIN	5 / 77	0.081 - 2.2	0.70	Does not exceed screening concentration
GAMMA-BHC	1 / 82	1 - 1	1.00	Detected at less than 5% frequency
HEPTACHLOR EPOXIDE	4 / 80	0.0058 - 0.6	0.24	
METHOXYCHLOR	1 / 82	0.053 - 0.053	0.053	Does not exceed screening concentration

NL - Not Listed

ND - Not Detected

(1) Only samples with detects where used when calculating average concentrations for each compound.

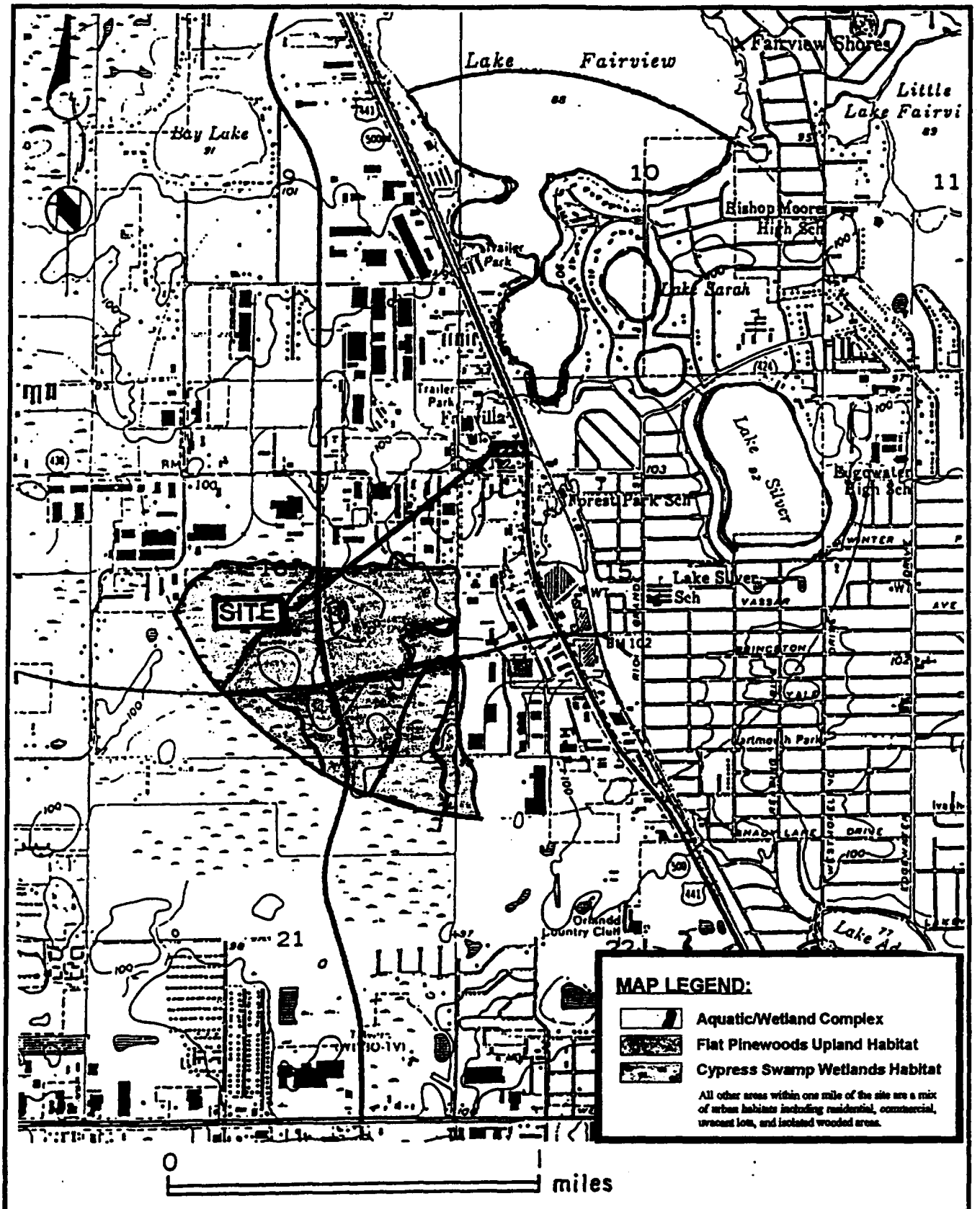
TABLE 7-2
CHEMICALS DETECTED IN GROUNDWATER
CHEVRON ORLANDO SITE

Chemical	Frequency of Detection	Range of Detects (ug/l)	Average Detected Concentration (1) (ug/l)	Region IV Screening Values (2) (ug/l)	REASON FOR ELIMINATION (if applicable)
VOLATILE ORGANICS					
1,1-DICHLOROETHANE	3 / 25	0.8 - 9.7	5.0	NL	
1,2-DICHLOROBENZENE	5 / 25	2.6 - 8	4.0	15.8	Does not exceed screening concentration
1,2-DICHLOROPROPANE	1 / 25	0.8 - 0.8	0.8	525	Does not exceed screening concentration
1,4-DICHLOROBENZENE	6 / 25	5.7 - 24	11.4	11.2	
BENZENE	8 / 25	1.1 - 22	6.6	53	Does not exceed screening concentration
CHLOROBENZENE	9 / 25	1.4 - 62	15.9	195	Does not exceed screening concentration
CHLOROFORM	1 / 25	2.3 - 2.3	2.3	289	Does not exceed screening concentration
ETHYLBENZENE	11 / 25	0.9 - 2000	250	453	
TOLUENE	7 / 25	1.2 - 12	6	175	Does not exceed screening concentration
XYLENES	12 / 25	4 - 5900	659	NL	
BASE NEUTRAL ORGANICS					
1,2,4-TRICHLOROBENZENE	1 / 25	20 - 20	20	44	Does not exceed screening concentration
2,4-DIMETHYLPHENOL	2 / 25	22 - 28	25	21.2	
2-METHYLNAPHTHALENE	8 / 25	28 - 110	52	NL	
2-METHYLPHENOL	1 / 25	26 - 26	26	NL	Detected at less than 5% frequency
DI-N-BUTYL PHTHALATE	7 / 25	10 - 84	33	9.4	
NAPHTHALENE	3 / 25	38 - 112	64	62	
PCB-1260	3 / 25	2 - 45	17	0.014	
PESTICIDE/PCBs					
4,4'-DDD	2 / 25	2.3 - 3	2.7	0.006	
ALPHA-BHC	11 / 25	0.14 - 9.2	2.9	500	Does not exceed screening concentration
BETA-BHC	11 / 25	0.32 - 70	10	5000	Does not exceed screening concentration
CHLORDANE	1 / 25	12 - 12	12.0	0.004	
DELTA-BHC	11 / 25	0.09 - 37	8.9	NL	
GAMMA-BHC	3 / 25	1 - 3.8	1.9	0.08	
NALED	1 / 25	14 - 14	14.0	NL	Detected at less than 5% frequency
PARATHION ETHYL	1 / 25	15 - 15	15	NL	Detected at less than 5% frequency
INORGANICS					
ARSENIC	3 / 25	11 - 46	25	190	Does not exceed screening concentration
CHROMIUM *	10 / 25	0.05 - 1.8	0.27	11	Does not exceed screening concentration
LEAD	21 / 25	5 - 330	61	1.320	

NL - Not Listed
ND - Not Detected
(1) Only samples with detects where used when calculating average concentrations for each compound.
(2) These values were obtained from EPA Region IV chronic screening concentrations for the protection of aquatic life.
* The Screening Value is for Chromium VI

Table 7-3
Chemicals of Potential Concern
Chevron Orlando Site
Risk Assessment

Contaminant	Media	
	Onsite Soil	Groundwater
VOLATILE ORGANICS		
1,1-DICHLOROETHANE		X
1,2-DICHLOROBENZENE		
1,2-DICHLOROPROPANE		
1,4-DICHLOROBENZENE		X
BENZENE		
CHLOROBENZENE		
CHLOROFORM		
ETHYLBENZENE		X
TOLUENE		
XYLENES		X
BASE NEUTRAL ORGANICS		
1,2,4-TRICHLOROBENZENE		
2,4-DIMETHYLPHENOL		X
2-METHYLNAPHTHALENE		X
2-METHYLPHENOL		
DI-N-BUTYL PHTHALATE		X
NAPHTHALENE		X
PCB-1260		X
PESTICIDE/PCBs		
4,4'-DDD	X	X
4,4'-DDE	X	
4,4'-DDT	X	
ALDRIN	X	
ALPHA-BHC		
BETA-BHC	X	
CHLORDANE	X	X
DELTA-BHC		X
DIELDRIN	X	
ENDRIN		
GAMMA-BHC		X
HEPTACHLOR EPOXIDE	X	
METHOXYCHLOR		
NALED		
PARATHION ETHYL		
INORGANICS		
ARSENIC		
CHROMIUM		
LEAD		X



Site Location and Ecological Receptor Map Chevron Chemical Company/Ortho Division	Figure 7-1
	Technical Memorandum II Remedial Investigation Orlando, Orange County, Florida

7.1.1.1 Threatened and Endangered Species. A review of threatened and endangered species in the Orange County area has indicated that there are none that would be likely to utilize the habitat found at the Chevron Orlando site.

One Federally-endangered avian species, bald eagle (*Haliaeetus leucocephalus*) is known to have a nesting location within 3 miles of the Chevron Orlando site (FNAI, 1994). The bald eagle is a large top-level carnivore that feeds primarily on fish from rivers and lakes (Farrand, Jr, 1988). While bald eagles are particularly sensitive to pesticide contamination, there is little potential for onsite pesticide contamination to impact nearby surface waters that would be suitable habitat.

There are no other known threatened or endangered species of flora or fauna on or near the site; however, several of these species are known to be present in Orange County (FNAI, 1994). A list of these species and the habitat these are found in are included in Table 7-4.

7.1.1.2 Other Potentially Exposed Species. Based on the site conditions and the fate/transport characteristics of the site contaminants, there is little likelihood of contaminants migrating off-site. As such, the habitat and ecological receptors most likely to be exposed to contamination from the site are those present on the site.

While there are some significant habitat areas and an endangered species present within three miles of the site, there are no complete contaminant migration pathways from the Chevron Orlando site to these areas, therefore, there is little risk of exposure.

The habitat provided on the site is a typical urban open field habitat which has been heavily disturbed by anthropomorphic activity for over 30 years. A more recent soil excavation and backfill, associated with remedial activities, occurred on the site in the past two years. A list of the species which were observed on the site during the reconnaissance is presented in Table 7-5.

Based on the species observed and professional judgement, it is likely that there are also soil invertebrates (earthworms), and small mammals (squirrels, mice, shrew) utilizing portions of the site. The vegetation species observed on the Chevron Orlando site are typical pioneer species in an urban ecosystem and were not determined to be of significant concern.

3 12 0109

Table 7-4
Threatened and Endangered Species in Orange County, Florida
Chevron Orlando Site Risk Assessment
Orlando, Orange County, Florida

Common Name	Scientific Name	Habitat	Status
Amphibians			
Gopher frog	*Rana capito*	W,L	C2
Reptiles			
Eastern indigo snake	*Drymarchon corais*	T1,T2,W	FT, ST
Gopher tortoise	*Gopherus polyphemus*	T1,T2	C2
Sand skink	*Neoseps reynoldsi*	T2	FT, ST
Florida scrub lizard	*Sceloporus woodi*	T2	C2
Short-tailed snake	*Stilosoma extenuatum*	T2	C2, LT
Birds			
Florida scrub jay	*Aphelocoma coerulescens*	T1,T2	FT, ST
Florida sandhill crane	*Grus canadensis*	T2,W,L	ST
Bald eagle	*Haliaeetus leucocephalus*	W,L,R	FE, ST
Red-cockaded woodpecker	*Picoides borealis*	T1,T2	FE, ST
Mammals			
Florida mouse	*Podomys floridanus*	T1,T2	C2
Sherman's fox squirrel	*Sciurus niger*	T1,T2,W	C2
Florida black bear	*Ursus americanus*	T1,T2,W	C2, LT
Invertebrates			
Wewika aphaostracon	*Aphaostracon monas*	L,R	C2
Wewika snail	*Cincinnatia wekiwae*	L,R	C2
Plants			
Curtiss' milkweed	*Asclepias curtissii*	T1,T2	SE
Florida bonamia	*Bonamia grandifolia*	T2	FT,SE
Beautiful pawpaw	*Deeringothamnus pulchellus*	T1	FE,SE
Scrub buckwheat	*Eriogonum longifolium*	T2	FT,ST
Nodding pinweed	*Lechea cernua*	T1,T2	SE
Scrub lupine	*Lupinus aridorum*	T2	FE, SE
Fall-flowering ixia	*Nemastylis floridana*	T1,W	C2, SE
Florida bear-grass	*Nolina atopocarpa*	T1	C2, SE
Britton's bear-grass	*Nolina brittoniana*	T2	FE, SE
Hand fern	*Ophioglossum palmatum*	W	SE
Paper-like nailwort	*Paronychia chartac ea*	W	FT, SE
Lewton's polygala	*Polygala lewtonii*	T2	FE, SE
Small's jointweed	*Polygonella myriophylla*	T2	FE
Scrub plum	*Prunus geniculata*	T2	FE, SE
Casping warea	*Warea amplexifolia*	T2	FE, SE

Legend for Habitat:	Legend for Status
T1 - Terrestrial, forested	C2 - Candidate for Federal List
T2 - Terrestrial, scrub	FE - Federally Endangered
W - Wetlands	FT - Federally Threatened
L - Lakes	SE - State Endangered
R - Rivers	ST - State Threatened

Table 7-5
Plant and Animal Species Observed on the Chevron Orlando Site
Orlando, Orange County, Florida

Common Name	Scientific Name
Birds	
Cattle egret	*Bubulcus ibis*
Mourning dove	*Zenaida acroura*
Common crow	*Corvus brachyrhynchos*
Insects	
Gulf fritillary butterfly	*Agrauiis vanillae*
Zebra swallowtail butterfly	*Graphium marcellus*
Ants	Family Formicidae
Plants	
Grasses	Family Poacea
Spanish needles	*Bidens alba*
Rattle-box	*Crotalaria spectabilis*
Black medic	*Medicago lupulina*
Indian clover	*Melilotus indica*
Blue toadflax	*Linaria canadensis*
Standing cypress	*Ipomopsis rubra*
Wild olive	*Osmanthus americana*
Myrtle oak	*Quercus myrtifolia*
Red maple	*Acer rubrum*
Saw palmetto	*Serenoa repens*
Cabbage palm	*Sabal palmetto*
Coastal plain willow	*Salix caroliniana*

7.1.2 Ecological Conceptual Model.

The ecological conceptual site model for the Chevron Orlando site (Figure 7-2) incorporates information on the potential chemical sources, affected media, release mechanisms, routes of migration, and known or potential ecological receptors. The purpose of the ecological conceptual site model is to provide a framework with which to identify potential exposure pathways that may impact ecological receptors on or near the site. Information presented in the Contamination Assessment and Removal Action Reports, local land and water uses, and potential receptors is used to identify potential exposure pathways at the site.

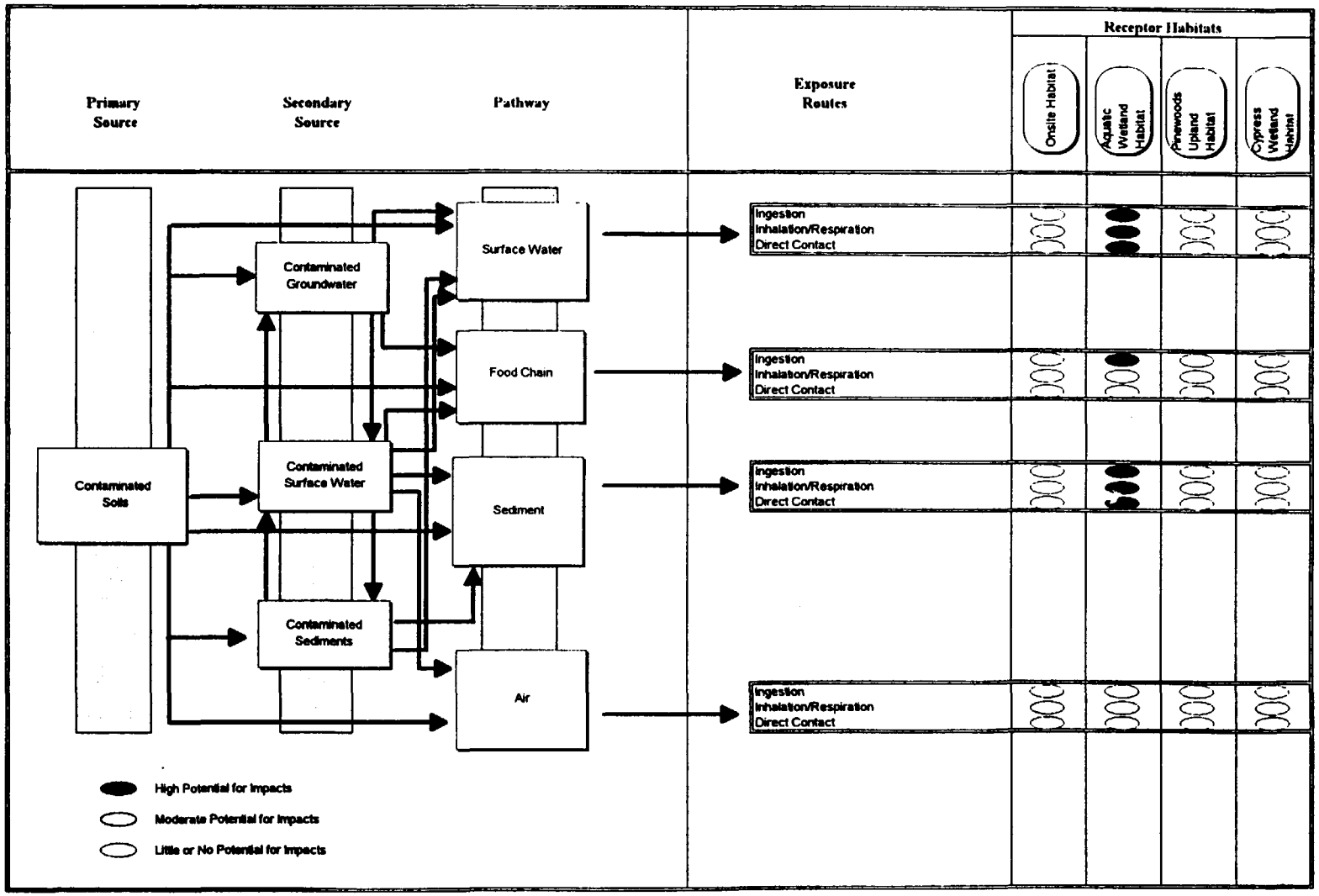
7.1.3 Exposure Pathway and Receptor Analysis

An exposure pathway is defined for the purpose of this investigation as a route by which a contaminant might potentially be transported from the source to the exposed individual within a particular habitat (USEPA, 1989). An exposure pathway generally consists of four elements, a source and mechanism of chemical release, a retention of transport medium, a point of potential contact for ecological receptors, and an exposure route. For instance, contaminated sediments may be transported from a source area on the site to a nearby river by overland storm water runoff, where they are ingested by benthic macroinverterates. The migration pathways which are considered most important to the Chevron site are discussed below. The conceptual model for the baseline ecological risk assessment is presented in Figure 7-2.

7.1.3.1 Soil Exposure Pathway. The soils at the site constitute not only a source but also a transport media in the soil exposure pathway. The receptors in this case are the organisms present in the terestrial habitats located onsite. The exposure routes which are likely to play the most important roles in this pathway are direct exposure and ingestion. Many of the surface and subsurface soils at the site were found to contain site related contaminants. The soil exposure pathway is thought to play a relatively important role in the transport of these contaminants to terrestrial receptor populations located on the Chevron site.

7.1.3.2 Surface Water Pathway. The contaminated soils at the site constitute the primary source for the surface water pathway. Secondary sources would include contaminated sediments and groundwater. The topography of the site is relatively flat so rainfall runoff along with any leached contaminants would tend to stand and percolate into the ground. There are, however, drainage ditches or drainage pipes which would tend to concentrate and divert runoff off the site property. Although

FIGURE 7-2
CONCEPTUAL SITE MODEL
ECOLOGICAL ASSESSMENT
CHEVRON CHEMICAL, ORLANDO



runoff is not likely to leave the site during small rainfall events, the surface water pathway may play a larger role in the migration of site related contaminants during large episodic rainfall events in which flooding occurs. The primary receptors for the surface water pathway include the organisms present in aquatic habitats to the northeast of the site. The primary routes of exposure include respiration, direct contact, and ingestion. It is also important to note that the surface water runoff from the site may act as a secondary source for both the groundwater and sediment pathways.

7.1.3.3 Sediment Pathway. The contaminated soils at the site constitute the primary source for the sediment pathway. Secondary sources would include surface water. The topography of the site is relatively flat so rainfall runoff would tend to stand and percolate into the ground. However, during large episodic rainfall events soils at the site may be carried into nearby municipal drainage structures eventually to become sediments in nearby surface water bodies. These sediments could then be further transported by additional rainfall events. The primary receptors for the sediment pathway are the organisms present in the aquatic habitats to the northeast of the site. The primary routes of exposure are direct contact and ingestion. It is important to note that the sediments also serve as secondary sources for the surface water pathway.

7.1.3.4 Groundwater Pathway. The primary sources of contamination for the groundwater pathway are the contaminated soils at the site. Secondary sources would include surface water. Because rainfall at Chevron Chemical tends to stand on the relatively flat terrain of the site before percolating into the ground and because shallow groundwater at the site tends to move toward adjacent surface water bodies, the groundwater pathway plays a relatively important role in the migration of site related contaminants from primary source areas. Although the groundwater pathway may be considered a complete exposure pathway, it is perhaps more important at the Chevron site as a secondary source for the surface water pathway. For this reason it will not be treated as a complete exposure pathway for this BERA.

7.1.3.5 Air Pathway. The primary source for the air pathway is the contaminated soils at the site. The air pathway may serve to move contaminants from primary source areas at the site via either direct volatilization of contaminants or by the transport of contaminants adsorbed to particulate matter. Because the majority of the site area is relatively well vegetated and the contaminants found at the site are for the most part non-volatile, the air pathway is thought to be of little importance in the migration of contaminants from primary sources at the site.

7.2 Exposure Assessment

This section will discuss the potential for ecological receptors identified on or near the Chevron Orlando site to become exposed to the ecological chemicals of potential concern. This potential will be based on the physical ability for contaminants on or near the site to impact ecological receptors.

7.2.1 Exposure Point Concentrations

The exposure point concentration is the concentration of a contaminant in an environmental media to which a specific receptor is exposed. It is generally calculated using statistical methodology from a set of data derived from environmental sampling. The specific methodology used to derive the exposure point concentrations in the BERA is presented below.

- For chemicals and media in which the number of samples is less than 10 the maximum concentration detected will be used to represent the exposure point concentration.
- For chemicals and media in which the number of samples exceeds 10, the upper 95% confidence limit (UCL) of the arithmetic mean will be used to represent the exposure point concentration.
- For chemicals and media in which the UCL is unreasonable due to the large standard deviation of the statistical sample, the maximum concentration detected will be used to represent the exposure point concentration.

The exposure point concentrations for the terrestrial receptors are the values presented in Table 7-6. Table 7-7 presents the exposure point concentrations for aquatic receptors.

7.2.2 Exposure Estimates

Total exposure of two surrogate terrestrial receptors (american robin and cottontail rabbit) to ECOPCs in surficial soils was determined by estimating the chronic daily intake (CDI) dose. These species were selected as surrogate species because they are both common in the study area.

Table 7-6
Onsite Soil Samples (Surface)
Chevron Orlando Site
Risk Assessment

Compound or Analyte (mg/kg)	95% Upper Confidence Limit	Maximum Value	Exposure Point Concentration
PESTICIDE/PCBs			
4,4'-DDD	2.5E+00	2.1E+01	2.5E+00
4,4'-DDE	1.1E+00	3.1E+00	1.1E+00
4,4'-DDT	1.4E+00	5.8E+01	1.4E+00
ALDRIN	1.2E+00	1.3E+01	1.2E+00
BETA-BHC	1.1E+00	2.1E+01	1.1E+00
CHLORDANE	8.6E+00	7.9E+01	8.6E+00
DIELDRIN	1.2E+00	1.1E+01	1.2E+00
HEPTACHLOR EPOXIDE	9.3E-01	6.0E-01	6.0E-01

Table 7-7
Shallow Groundwater
Chevron Orlando Site
Risk Assessment

Compound or Analyte (ug/l)	95% Upper Confidence Limit	Maximum Value	Exposure Point Concentration
VOLATILE ORGANICS			
1,1-DICHLOROETHANE	1.0E+00	9.7E+00	1.0E+00
1,4-DICHLOROBENZENE	5.6E+00	2.4E+01	5.6E+00
ETHYLBENZENE	2.4E+06	2.0E+03	2.0E+03
XYLENES	2.9E+04	5.9E+03	5.9E+03
BASE NEUTRAL ORGANICS			
1,2,4-TRICHLOROBENZENE	6.1E+00	2.0E+01	6.1E+00
2,4-DIMETHYLPHENOL	7.4E+00	2.8E+01	7.4E+00
2-METHYLPHENOL	6.3E+00	2.6E+01	6.3E+00
DI-N-BUTYL PHTHALATE	1.8E+01	6.4E+01	1.8E+01
NAPHTHALENE	1.4E+01	1.1E+02	1.4E+01
PCB-1260	2.1E+00	4.5E+01	2.1E+00
PESTICIDE/PCBs			
4,4'-DDD	3.2E-01	3.0E+00	3.2E-01
CHLORDANE	1.4E+00	1.2E+01	1.4E+00
DELTA-BHC	1.5E+02	3.7E+01	3.7E+01
GAMMA-BHC	2.6E-01	3.6E+00	2.6E-01
INORGANICS			
LEAD	1.2E+02	3.3E+02	1.2E+02

7.2.2.1 Target Organism - American Robin. The pathways being evaluated for the robin include the incidental ingestion of soil and the food chain pathway. The estimated CDI dose of the american robin was determined through the use of the following equation:

$$E = \frac{(Cw)(Iw) + [(Cs)(Bv) + (Cs)(Is) + (Cwor)(Iwor)](H)}{BW}$$

Where:

E	=	Total Exposure, mg/kg/d
Cw	=	Constituent concentration in the surface water, mg/L
Iw	=	Drinking water ingestion rate, L/d
Cs	=	Constituent concentration in soil, mg/kg
Bv	=	Soil to plant transfer coefficient, unitless
Iv	=	Rate of vegetation ingestion, kg/d
Is	=	Incidental soil ingestion, kg/d
Iwor	=	Rate of worm ingestion, kg/d
Cwor	=	Constituent concentration in the worm, mg/kg
H	=	Contaminated area/Home area range area ratio, unitless
BW	=	Body weight

The drinking water portion of this equation was not evaluated because there are no appreciable sources of drinking water on the site and because the closest source of drinking water is not likely affected by contaminants present at the site. The concentration of contaminant in the worm was determined through the use of a diet-to-invertebrate transfer coefficient for metals and a modeled bioconcentration factor (BCF) for organics. A transfer coefficient of 0.06, used for all metals, was multiplied by the concentration of each surface soil constituent to determine the concentration in the worm assuming the worm's diet is 100 percent soil (Talmadge 1993). For all organics, a modeled BCF of 0.25 was used (Menzie 1992). The modeled BCF value is independent of the octanol-water partition coefficient but depends on the lipid content of the animal and the fraction organic content of the soil. The BCF was multiplied by the concentration of each surface soil constituent to determine the concentration in the worm.

Bioconcentration of the ECOPCs was calculated using soil to plant transfer coefficients (Bv) for organics (Travis 1988) and metals (Baes 1984). Where Bv coefficients were not available for an ECOPC, a conservative coefficient of 1 was used, which assumes that all chemical is transferred from the soil to the plant. The concentration of the ECOPCs in the soil (Cs) were the maximum detected concentration or the UCL. For purposes of this assessment, intakes for two surrogate terrestrial receptors were determined. For the American robin, the feeding rate is 0.009 kg/d (Levey 1989). The incidental soil ingestion rate is 0.0008 kg/d (Beyer 1991). The rate of drinking water ingestion is 0.01 L/d (Calder 1983). The rate of vegetation ingestion is 0.004 kg/d, and the rate of worm ingestion is 0.004 kg/d. The body weight of the robin is 0.078 kg (Levey 1989), and the home range is 1.037 acres (Pitts 1984). The area of contamination was assumed to be approximately 2 acres to account for the removal actions at the site. The total exposure calculations for the American robin to ECOPCs are provided in Table 7-8.

7.2.2.2 Target Organism - Eastern Cottontail Rabbit. The pathways being evauated for the eastern cottontail rabbit are the incidental ingestion of soil and the food chain pathway. The estimated CDI dose of the cottontail rabbit was determined through the use of the following equation:

$$E = \frac{(Cw)(Iw) + [(Cs)(Bv)(Iv) + (Cs)(Is)]\,(H)}{BW}$$

Where:

E	=	Total Exposure, mg/kg/d
Cw	=	Constituent concentration in the surface water, mg/L
Iw	=	Drinking water ingestion rate, L/d
Cs	=	Constituent concentration in soil, mg/kg
Bv	=	Soil to plant transfer coefficient, unitless
Iv	=	Rate of vegetation ingestion, kg/d
Is	=	Incidental soil ingestion, kg/d
H	=	Contaminated area/Home area range area ratio, unitless
BW	=	Body weight

The drinking water portion of this equation was not evaluated because there are no appreciable sources of drinking water on the site and because the closest source of drinking water is not likely affected by contaminants present at the site.

Table 7-8
Exposure of Robin to ECOPCs
in Surficial Soil Samples
Chevron Orlando Ecological Risk Assessment
Orlando, Orange County, Florida

ECOPC	Cw	Iw	Cs	Bv	Iv	Is	TCoef	BCF	Cwor	Iwor	H	BW	Exposure
Pesticides/PCBs													
Dieldrin	0.00E+00	0.01	1.20E+00	1	0.004	0.0008	n/a	0.25	3.00E-01	0.004	1.000	0.078	8.86E-05
4,4'-DDD	0.00E+00	0.01	2.50E+00	0.101	0.004	0.0008	n/a	0.25	6.25E-01	0.004	1.000	0.078	9.65E-05
4,4'-DDT	0.00E+00	0.01	1.40E+00	0.102	0.004	0.0008	n/a	0.25	3.50E-01	0.004	1.000	0.078	3.04E-05
4,4'-DDE	0.00E+00	0.01	1.10E+00	0.003	0.004	0.0008	n/a	0.25	2.75E-01	0.004	1.000	0.078	1.26E-05
Heptachlor Epoxide	0.00E+00	0.01	6.00E-01	1	0.004	0.0008	n/a	0.25	1.50E-01	0.004	1.000	0.078	2.22E-05
Chlordane	0.00E+00	0.01	8.60E+00	0.467	0.004	0.0008	n/a	0.25	2.15E+00	0.004	1.000	0.078	2.53E-03
Aldrin	0.00E+00	0.01	1.20E+00	0.467	0.004	0.0008	n/a	0.25	3.00E-01	0.004	1.000	0.078	4.93E-05
b-BHC	0.00E+00	0.01	1.10E+00	0.467	0.004	0.0008	n/a	0.25	2.75E-01	0.004	1.000	0.078	4.14E-05

Notes

(1) Bv value could not be determined for all contaminants. For the purposes of this study, a conservative value of 1 was used.

Legend

Cw	=	Constituent concentration in the drinking water, mg/l
Iw	=	Rate of drinking water ingestion, L/d
Cs	=	Constituent concentration in soil, mg/kg
Bv	=	Soil to plant transfer coefficient, unitless
Iv	=	Rate of vegetation ingestion, kg/d
Is	=	Incidental soil ingestion, kg/d
Tcoef	=	Transfer coefficient for metals in soils to worms, unitless
BCF	=	Bioaccumulation factor for organics in soils to worms, unitless
Iwor	=	Rate of worm ingestion, kg/d
Cwor	=	Constituent concentration in the worm, mg/kg
H	=	Contaminated area/Home area range ratio, unitless
BW	=	Body weight, kg

Bioconcentration of the ECOPCs was calculated using soil to plant transfer coefficients (Bv) for organics (Travis 1988) and metals (Baes 1984). Where Bv coefficients were not available for an ECOPC, a conservative coefficient of 1 was used, which assumes that all chemical is transferred from the soil to the plant. The concentration of the ECOPCs in the soil (Cs) was the average of all concentrations detected.

For the cottontail rabbit, the feeding rate is 0.01 kg/d (Newell, 1987). The incidental soil ingestion rate is 0.001 kg/d (Newell, 1987). The rate of drinking water ingestion is 0.013 L/d (Federal Register, 1993). The rate of vegetation ingestion is 0.1 kg/d. The body weight is 2 kg (Newell, 1987), and the home range is 10 acres. The area of contamination was assumed to be approximately 2 acres to account for the removal actions at the site. The total exposure calculations for the cottontail rabbit to ECOPCs is provided in Table 7-9.

7.3 Ecological Effects Assessment

The potential ecological effects to terrestrial receptors were evaluated by comparing the known contaminant concentrations to existing scientific literature or by comparing the chronic daily intake (CDI) to toxicity reference values (TRVs).

Terrestrial habitats are the principle habitat potentially impacts by contaminants at the Chevron Orlando site. The measurement endpoint used in evaluating the effects of the ECOPCs on the viability of the terrestrial receptors will include Toxicity Reference Values (TRV) developed from No-Observed-Adverse-Effect-Level (NOAELs) or Lowest-Observed-Adverse-Effect-Levels (LOAELs) obtained from the Integrated Risk Information System (IRIS, 1993) or other toxicological data in the literature. Total exposure of two surrogate terrestrial receptors (american robin and cottontail rabbit) to ECOPCs in surficial soils was determined by estimating the chronic daily intake (CDI) dose. This CDI was then compared to the TRV to determine if the concentrations of ECOPCs are protective of total species viability for each of the habitats of concern.

An assessment of the potential impact of groundwater contamination on surfacewater bodies near the site will be made by direct comparrison of Ambient Water Quality Criteria with the concentrations found in shallow groundwater.

Table 7-9
Exposure of Cottontail Rabbit to ECOPCs in Surficial Soil Samples
Chevron Orlando Ecological Risk Assessment
Orlando, Orange County, Florida

ECOPC	Cw	Iw	Cs	Bv	Iv	Is	H	BW	Exposure
Pesticides/PCBs									
Dieldrin	0.00E+00	0.185	1.20E+00	1	0.01	0.0008	0.200	2.000	1.30E-03
4,4'-DDD	0.00E+00	0.185	2.50E+00	0.101	0.01	0.0008	0.200	2.000	4.53E-04
4,4'-DDT	0.00E+00	0.185	1.40E+00	0.102	0.01	0.0008	0.200	2.000	2.55E-04
4,4'-DDE	0.00E+00	0.185	1.10E+00	0.003	0.01	0.0008	0.200	2.000	9.13E-05
Heptachlor Epoxide	0.00E+00	0.185	6.00E-01	1	0.01	0.0008	0.200	2.000	6.48E-04
Chlordane	0.00E+00	0.185	8.60E+00	0.467	0.01	0.0008	0.200	2.000	4.70E-03
Aldrin	0.00E+00	0.185	1.20E+00	0.467	0.01	0.0008	0.200	2.000	6.56E-04
b-BHC	0.00E+00	0.185	1.10E+00	0.467	0.01	0.0008	0.200	2.000	6.02E-04

Notes

(1) Bv value could not be determined for all contaminants. For the purposes of this study, a conservative value of 1 was used.

Legend

Cw	=	Consituent concentration in the drinking water, mg/l
Iw	=	Rate of drinking water ingestion, L/d
Cs	=	Constituent concentration in soil, mg/kg
Bv	=	Soil to plant transfer coefficient, unitless
Iv	=	Rate of vegetation ingestion, kg/d
Is	=	Incidental soil ingestion, kg/d
H	=	Contaminated area/Home area range ratio, unitless
BW	=	Body weight, kg

7.4 Risk Characterization

Risk characterization is the final phase of a risk assessment. It is at this phase that the likelihood of adverse effects occurring as a result of exposure to a stressor are evaluated.

There are no standards, criteria, or other screening values for assessing the potential impacts to terrestrial ecological receptors from contaminants in soils. Additionally, the amount of literature data evaluating adverse ecological effects on terrestrial species exposed to surface soils is limited. Therefore, a CDI dose model was used to determine total exposure of two surrogate terrestrial receptors. The CDI was then compared to toxicological reference values (TRVs) representing acceptable daily doses in mg/kg/day.

Table 7-10 shows the total exposures of all detected ECOPCs to two surrogate terrestrial receptors based on the CDI model performed in the Exposure Assessment. The total exposure for each surrogate was compared to the TRV for each ECOPC. The ratios of the total exposure TRV values were calculated for each ECOPC, resulting in a hazard quotient (HQ). This was done independently for each surrogate. Additionally, the cumulative risks of the ECOPCs was evaluated by summing the HQs for all ECOPCs resulting in a quotient index (QI). The QIs for the robin and the cottontail rabbit were 5.44 and 5.12, respectively. This would indicate increased risk to terrestrial receptors. All of the ECOPCs are found at concentrations in excess of the Region IV screening criteria. In addition, the EPC for lead is in excess of the AWQC. This would indicate some potiential increased risk to aquatic receptors should contaminated groundwater migrate into nearby surface water bodies.

The bald eagle is the only threatened or endangered species known to be present near the site. A nest of bald eagles is known to be present approximately 3 miles from the site.

The bald eagle is not believed to be at risk of exposure to ECOPCs at or from the Chevron Orlando site, since it does not normally utilize the habitats that are impacted by ECOPCs.

Table 7-10
Quotient Indicies for Terrestrial Receptors
Chevron Orlando Ecological Risk Assessment
Orlando, Orange County, Florida

ECOPC	EPC	Exposure Robin	Exposure Cottontail	TRV Robin	TRV Cottontail	HQ Robin	HQ Cottontail
Pesticides/PCBs		mg/kg/day	mg/kg/day	mg/kg/day	mg/kg/day		
Dieldrin	1.20E+00	8.86E-05	1.30E-03	5.00E-04	6.00E-03	1.77E-01	2.16E-01
4,4'-DDD	2.50E+00	9.65E-05	4.53E-04	1.74E-02	3.48E-02	5.54E-03	1.30E-02
4,4'-DDT	1.40E+00	3.04E-05	2.55E-04	1.74E-02	1.00E-02	1.74E-03	2.55E-02
4,4'-DDE	1.10E+00	1.26E-05	9.13E-05	5.00E-03	3.26E+00	2.52E-03	2.80E-05
Heptachlor Epoxide	6.00E-01	2.22E-05	6.48E-04	2.50E-01	NA	8.86E-02	
Chlordane	8.60E+00	2.53E-03	4.70E-03	5.00E-04	1.00E-03	5.06E+00	4.70E+00
Aldrin	1.20E+00	4.93E-05	6.56E-04	5.00E-04	1.00E-02	9.85E-02	6.56E-02
b-BHC	1.10E+00	4.14E-05	6.02E-04	6.00E-03	6.00E-03	6.90E-03	1.00E-01
QI						5.44E+00	5.12E+00

* TRV values derived from NOEL or LOEL values in IRIS

TRV - Toxicity Reference Dose

HQ - Hazard Quotient

HI - Hazard Index

EPC - Exposure Point Concentration

7.5 Uncertainty

There are a number of points in the decision making process of an ecological risk assessment where there are inherent uncertainties. As a result, it is often necessary to make certain assumptions to facilitate the preparation of the risk assessment. When data is lacking, conservative assumptions are made to be protective of the environment.

There is uncertainty in the ecological endpoint comparison. The values used in the ecological endpoint comparison (the TRVs) are set to be protective of a majority of the potential receptors. There will be some species that will not be protected by the values because of their increased sensitivity to the chemicals. Additionally, the toxicity of chemical mixtures is not well understood. The toxicity information used in the ecological risk assessment for evaluating risk to ecological receptors is for individual chemicals. Chemical mixtures can affect the receptors very differently than the individual chemicals. In addition, there were several chemicals that did not have TRVs. Therefore, potential effects of these chemicals to ecological receptors could not be determined.

During this Ecological Assessment, a number of conservative assumptions were made. The most significant of these conservative assumptions concerns the use of the CDI models to evaluate decreased viability to terrestrial receptors. Most of the input parameters are based on default values that may or may not adequately represent the actual values of the parameters. Additionally, there is a great deal of uncertainty in how appropriate the selected surrogate species are in representing the other species potentially exposed to ECOPCs at the site. Finally, terrestrial species will also be exposed to contaminants by ingesting other fauna at the site that have accumulated contaminants. This exposure route was not evaluated in the BERA because of the associated high uncertainty.

In calculating the CDI one other conservative technical assumption was made, adding to the uncertainty of the terrestrial receptor exposure assessment. The use of the maximum concentration of ECOPCs detected in surficial soils in probably an overly conservative assumption and therefore, adds some uncertainty to the terrestrial receptor exposure assessment.

7.6 Conclusions and Ecological Significance

The results of the BERA indicate that there are limited habitats on the Chevron Orlando site that are available to be impacted by ECOPCs at the site. Additionally, the surrounding areas are such that there is little to no potential for off-site migration of ECOPCs. Currently, the only species at risk from ECOPCs are those that may utilize the limited habitat provided at the site. Should the site be allowed to lie fallow for a number of years and suitable habitat be established, any number of important species may come to use the property. In addition, the potiential for groundwater to impact nearby aquatic habitat should also be noted.

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